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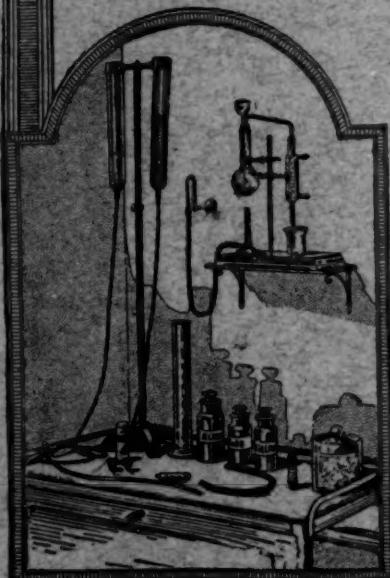
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LIGATION OF THE EXTERNAL ILIAC ARTERY AND VEIN ABOVE AND BELOW A COMMUNICATING BULLET WOUND OF THESE TWO VESSELS *

BY G. PAUL LA ROQUE, M.D.
OF RICHMOND, VA.

PISTOL bullets and stab instruments are the causes of approximately 80 per cent. of all cases of wounds of large arteries and veins in civil life. Fracture in the region of the shoulder and hip;⁹ accidental incisions or tears when operating upon such affections as hernia, abscess, bubo, carcinoma; iliac artery rupture following removal of a drainage tube seven days after its insertion at the site of removal of stones from the lower ureter;²⁰ pressure necrosis of the external iliac artery by forceps placed on the internal iliac to control hemorrhage during operation upon these vessels; accidental stab of the vessels in the groin by a child upon flexing the thigh while recovering from an anesthetic for the performance of circumcision (the knife lying on the sheet with its blade directly over the vessels);²⁶ accidental stab with scissors; these and others too numerous to mention have been the causes of injuries to these vessels.^{6, 18, 19}

Many surgeons have experienced genuine distress under the burden of anxiety for the first few days following treatment of such a wound as this and many have experienced the thrill of seeing the patient recover without gangrene after such a dramatic operation as suture or ligation of these great vessels. Some have had their initial distress followed by the terrible fear that the limb might become gangrenous during the period of observation; and can we picture the agony which must be experienced by a young and ambitious surgeon at seeing his patient bleed to death, or after prevention of this catastrophe, of anticipating loss of limb from gangrene following accidental injury to these great vessels while performing an operation for bubo or hernia?

Along with this lack of practice in the technic of suturing and tying large arteries and veins, the surgeon, when confronted by the management of such an injury, feels also need for clear-cut authoritative information which will lead him to pursue exactly the proper course in dealing with these injuries, often among the most dramatic situations in the practice of surgery. What to do, what not to do and when and how and why, these are the ques-

* Read before the Southern Surgical Association, Dec. 16, 1920.

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tions. Disappointment is apt to follow expectation to secure the information necessary to a solution of the problems, from a study of the clinical case reports in literature. The records of laboratory work fail to elicit the completely assembled practical instruction which one needs at his "finger tips" in clear-cut formulated plans of procedure. And finally when one proceeds to a study of the fundamental principles involved in the gross anatomy, histology, embryology and highly organized physiology of blood-vessels in the living human being, he might easily become so engrossed by the fascination of the study that it is quite conceivable for him to fail to see through the penetrating eye of the scientific investigator the broad perspective or "bird's-eye view" of the whole subject for practical application.

Until through the labor of some such combined artist, scientist, and philosopher as W. S. Halsted, all the problems are solved and definite authoritative information becomes available, there is justifiable reason for the publication of isolated case reports describing the exact nature of the lesion, the exact method of treatment, subsequent observations and the ultimate results of individual cases of such injuries.

On the night of August 25, 1920, Dr. W. M. Strickland, responding to a call for the ambulance, found a robust twenty-two-year-old negro man with a pistol bullet wound in the left groin, just below Poupart's ligament at a position corresponding to the location of the femoral vessels. He immediately plugged the wound with a small strip of gauze, placed over it a pad, and with the man's trousers belt buckled snugly over the pad, hurried to the Virginia Hospital, where I saw the patient within ten or fifteen minutes after his arrival. Case No. 20-3579.

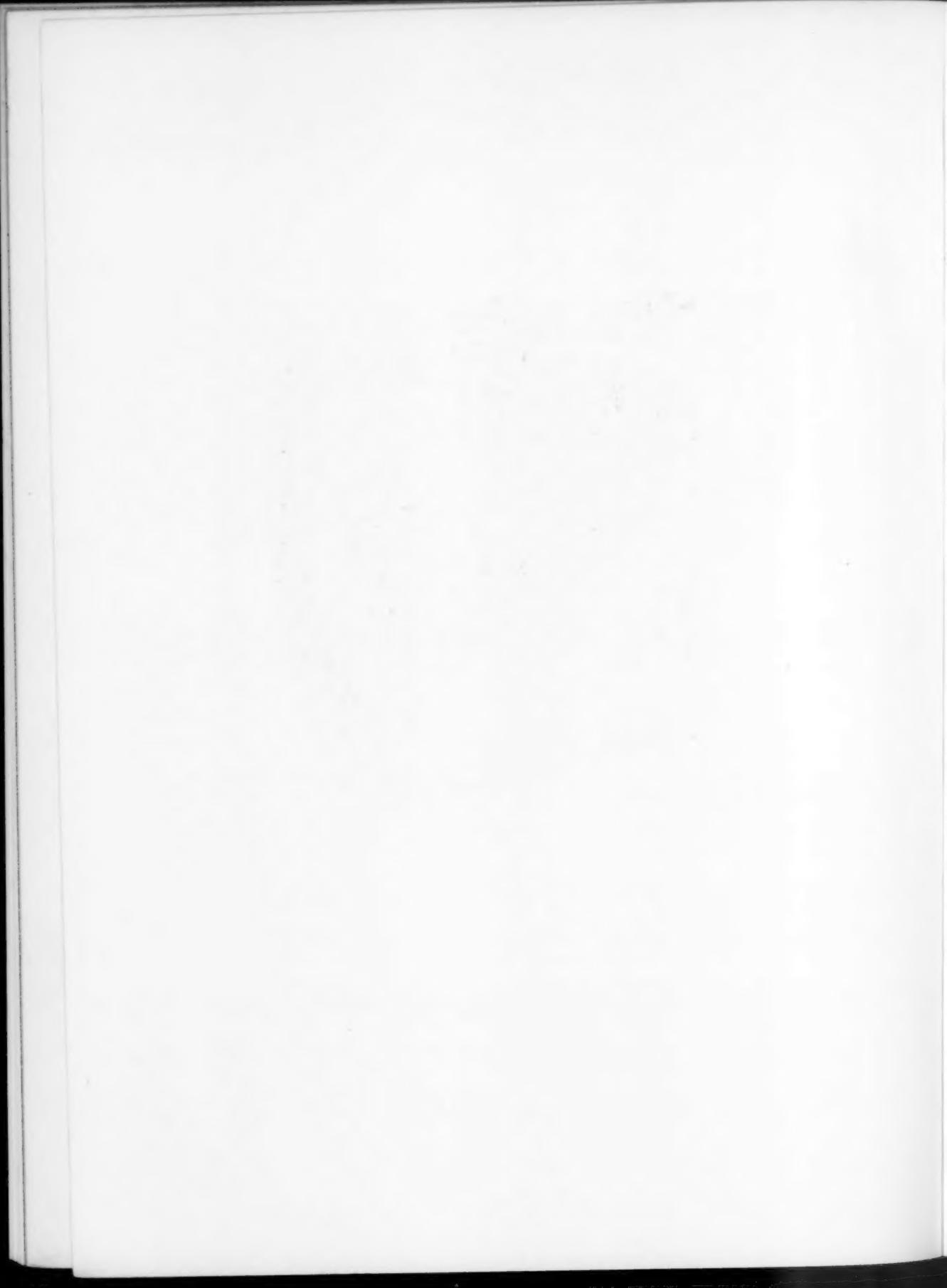
Examination showed moderate distention of the superficial veins of the thigh and leg and within an area of ten or twelve inches downward distinct venous pulsation. The arterial pulse of the foot and leg of the injured extremity was not palpable. On the opposite foot it was easily palpable and normal save for a rate of 110 per minute. Within the immediate vicinity and for a short distance above and below the wound, examination detected a rather violent systolic thrill and the characteristic traumatic aneurismal bruit. There was a small-sized area apparently of fluid blood beneath the skin in the immediate vicinity of the wound, but there was no external bleeding, the wound being distinctly of the "dry" variety. The man's general condition was excellent. X-ray examination showed the bullet in the buttock at a level slightly lower than that of entrance. There was no bone injury nor sign of intra-abdominal penetration.

Here then was a case of easily obvious communicating bullet wound of the common femoral artery and vein without external hemorrhage, without haematoma and in a healthy young man in a properly equipped hospital. The patient was immediately given $\frac{1}{4}$ grain of morphine sulph. and 1/50 grain of atropine sulph. and within an hour after being injured the operation was started.

After removal of the external dressing and painting the surrounding skin with tincture of iodine, a clean surgical approach to the iliac



FIG. 1.—Ligation of the external iliac artery and vein above and below a communicating bullet wound of these two vessels.



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vessels well above the site of injury was easily secured through the standard oblique incision for the extraperitoneal ligation of these vessels. Poupart's ligament was cut, the vessels were exposed and two sutures of twenty-day chromicized catgut No. 2 doubled, were placed around the external iliac artery about an inch above the wound and well above the deep epigastric and deep circumflex iliac vessels. These sutures were placed about one-half inch apart in position for instant ligation when necessary. With a good exposure, while Doctor Strickland made pressure on the artery with his fingers, I removed the six or eight inch strip of narrow gauze packing and made a longitudinal incision downward, encircling the ragged wound of entrance. This was excised and a small collection of blood wiped away. There was some welling upward of venous blood from the depths of the wound while looking for the location of the injury. Working gently and carrying the incision downward slowly the wounds in the artery and vein were found to be large, ragged and communicating. The ligatures above were immediately drawn tight. It was too late now to suture, even though the wound had been a suitable one for this procedure. We had "fractured" the artery and crushed its intima. The common femoral artery and vein were then clamped with forceps just above and below the wound and a formal excision of devitalized tissue, including the ragged edges of the vessel wounds, was made. The vessel ends were ligated and the surrounding tissue snugly sutured. The wound was dried, a small piece of soft flat rubber was laid in, and, but for a small place of exit, the skin wound was closed, dressings applied and the entire limb encircled with cotton from the pelvis to the toes. The patient was placed in bed with hot water bottles beside the limb and this heat was supplemented by the heat from an electric light under a tent over the leg. The patient's pulse at the end of the operation was 120. This may have been due to shock, though I was more anxious lest he might have serious dilatation of the heart. On this account and to facilitate whatever benefit the posture might have on the volume of blood in the limb, we elevated the head of the bed. He was also given a few hypodermic injections of one of the preparations of digitalis.

The next day the patient's general condition was excellent; he said he felt the external heat on his toes and foot and the limb was sweating. The second day he and his leg were still in good condition. After darkening the room, we exposed his toes and held behind them a flashlight. The pink color of the toes and nails under this translucency test gave us great comfort. Capillary response to pressure on the nails was prompt. A week after the operation I took the liberty of sticking a pin in his toe to see if it would bleed. It did. Ten days after operation the wound was healed, a few days later the bullet was removed from just beneath the skin on the buttock. External heat was kept applied for two weeks following the operation and a few days later he was allowed out of bed. A few days later he could walk without a limp and exhibited no evidence whatever of any impair-

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ment of function of any kind. A month after the operation he was doing ordinary light work and anything else he pleased. Two months after operation he was employed in active work as a combined janitor, butler and chauffeur. December 14, 1920, sixteen weeks after operation, examination fails to detect pulsation of the popliteal or any arteries of the foot. The region of the wound is hard, no evidence of tumor or pulsation is felt, the superficial veins of the foot are conspicuous but apparently normal. There is no difference in the size of the two extremities, the patient has no subjective symptoms of any kind and notices no difference in the sensations or usefulness of the two extremities. There are no differences in temperature, he walks long distances, runs up and down steps rapidly, uses the clutch and handles an automobile with ease, and with the exception of the lack of palpable arterial pulse, his extremity is normal.

DISCUSSION

Should Operation for this Type of Wound be Performed Immediately?

—I still remember having seen, twenty years ago, a man with a large traumatic arteriovenous aneurism, involving the iliac vessels, caused by a bullet wound received many years previously. He travelled about among medical students to exhibit himself as a means of livelihood. He was unable to do hard work; his lower extremity contained huge varicose veins and was greatly increased in size. Matas' contribution to this Association last year,^{11, 12} in which he reported numbers of cases of communicating wounds between arteries and veins operated upon at varying periods of from six weeks to fifteen years following injury, the case reported by Caldwell several years ago of injury to the subclavian artery operated upon ten days after injury, these and many other reports come quickly to one's memory. Certainly with these facts clearly before us and with a man losing no blood externally and with no haematoma, it would not have been easy to have said that the man here reported would have died if he had not been operated upon immediately.

It can, therefore, scarcely be claimed that immediate operation within the first few hours is urgently called for to save either life or limb in cases of bullet or stab inflicted communicating wounds of large arteries and veins, without external hemorrhage and without large haematoma. The large number of cases of arteriovenous aneurism in literature and the many recorded cases of war wounds successfully transported to distant hospitals, successfully controvert such a contention. These remarks, of course, did not have reference to those wounds accidentally inflicted by the operating surgeon and over which he has immediate control. But when an individual is shot or stabbed in these vessels it can scarcely be doubted that if he can survive long enough to be placed in a hospital and prepared for operation, he is not likely to die of hemorrhage *per se*, even though an operation is not performed. On the other hand a vessel wound bleeding so furiously as to demand immediate formal operation would be fatal

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before the anaesthetic could be administered and sterile linen and instruments arranged.

No argument is necessary to contend that unclean forceps, ligatures, packing or any such method of procedure should not be employed upon vessels in the depths of a ragged contaminated wound. The fact that these procedures are so likely to be followed by sepsis, by secondary hemorrhage and greatly increased liability of gangrene, supports the belief that even if it is demonstrable that patients do not always die of such wounds, even though not operated upon immediately, the dangers of infection, large hemorrhage and haematoma formation with the liability of gangrene due to thrombosis and pressure upon collateral arteries, constitute indications for reasonably prompt action. If in any case long delay is justifiable it must be in case of a clean-cut "dry" wound, bleeding from which may be adequately controlled by moderate pressure.

Acute dilatation of the heart is an immediate danger, the mechanism of which is easily comprehended when it is remembered that normally all the blood which should come into the limb is diverted hurriedly back to the heart. In young, healthy individuals acute dilatation may be survived; in individuals of middle age and especially with cardiac degeneration, death from acute dilatation of the heart may ensue promptly.

The studies of Halsted, of Callander, of Matas and many others clearly demonstrate that there are many real dangers to the life and limb of the patient from these lesions. Extensive proximal dilatation of the artery entails all the dangers of an arterial aneurism including the subsequent development of gangrene, and in addition Halsted^{15, 17} has conclusively shown that secondary dilatation of the heart is a part of the pathology of an arteriovenous fistula.

Is Deliberate Delay for the Purpose of Permitting the Establishment of Collateral Circulation a Well-founded Practice? Is there a physiologic or anatomic reason for this belief? On the contrary is there not much reason for believing that the development of circulation is antagonized by arteriovenous fistula? Many cases of arteriovenous aneurism have apparently caused gangrene partly by the pressure of the sac on the surrounding vessels, partly by infection and partly by arterial thrombosis. Certainly it is amply demonstrated that the normal quantity of arterial blood does not go to the distal portion, and this is necessarily followed by diminished arterial calibre followed by vessel hypoplasia. As a matter of fact, sufficient knowledge of the physiology and anatomy of the arteries and veins has already been acquired to demonstrate that there can be no advantage in delaying operation with the idea of establishing the new route of circulation. Is it not true that the most certain way to secure circulation in those areas where it is possible to secure it, is to put upon the tissues the necessity for it? It is tissue needs which cause the formation of new vessels and the enlargement of vessels already present and tissue needs which cause the vessels to function. The researches of physiologists and embryologists leave no room for doubt of this fundamental law of biology.

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We are, therefore, compelled to subscribe to the belief that for many reasons operation should be performed within a reasonably early length of time following the receipt of the injury, but that it is usually quite proper and often quite wise to delay operation for a few hours or even days to secure the services of a qualified surgeon, a properly equipped hospital and a clean field of operation. To estimate in practical terms the most suitable time for the performance of operations for contaminated and infected wounds implies a comprehension of the three stages of all infected wounds: the stage of contamination, the stage of infection, the stage of inflammation. It must be uniformly agreed that prompt excision of all devitalized tissue (*débridement*) should be performed as early as possible and with the greatest efficiency within at least twelve hours (the stage of contamination) and the operative wound completely closed as a clean wound. If performed after twelve hours (the stage of infection) the diminished efficiency of *débridement* is demonstrated by the frequency with which the wounds must be reopened and disinfected. Operation performed after thirty-six or forty-eight hours implies almost certainly the treatment of the wound for inflammation; and it is no longer open to doubt that inflammation of a wounded blood-vessel is the greatest danger to which it is liable. It is inflammation that results in thrombosis; inflammation that is followed by secondary hemorrhage; inflammation that causes gangrene. Pyæmia secondary to phlebitis constitutes a grave situation. Vascular wounds not operated upon within the first thirty-six or forty-eight hours and in which inflammation does not occur, may be operated upon for arteriovenous aneurism quite successfully at one's leisure.

What is the Exact Status of the Preliminary Tests for Collateral Circulation in Influencing the Treatment of the Injury to a Large Blood-Vessel?—Are the tests reliable indications, always applicable, and in case the tests are negative is it advantageous to delay action? To observe the downward flush after pressure upon the artery above the injury and accurately time its appearance is obviously not easy to do in negroes, for the flush can only be seen in the nails, the bottom of the feet and between the toes. It is quite obvious that even in white people there is considerable room for error in applying this test and much is dependent upon the adequacy of the light in which the test is made, the condition of the eyesight of the observer and other factors.

A prick of the toes or feet with a large-sized needle or small knife to produce bleeding would also be subject to some margin of error, for if there is a fistulous communication between the artery and the vein the veins even of the foot are slightly distended and bleed, and even in the absence of this a moderate amount of residual blood in the capillaries might lead one to a mistaken conclusion. Even though a justifiably deep puncture fails to cause a satisfactory amount of bleeding, does this justify a positive prognosis of gangrene?

A comparison of the surface temperature of the wounded extremity

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below the seat of injury is attended by considerably more chance of inaccuracy than is the case in the clinical use of the axillary temperature in the ordinary routine estimates of the body temperature, and we can easily conceive that after a bullet or stab wound involving a large vessel in the groin, the patient might be the victim of cold feet on both sides.

Palpation of the peripheral arterial pulse to determine what the condition of the circulation will be tomorrow or the next day is notoriously deficient in giving accurate information. Surgeons have known for years that frequently after injuries in the region of an artery in which the artery itself is not cut, there is a temporary obliteration of the pulse in the arteries distal to the injury, and this is not conclusive evidence that the circulation is totally or permanently cut off. The recent observations of Leriche, and for many years by Halsted,^{17, 18} that spastic contraction of the artery at a point distal to the location of the trauma incident to handling large blood-vessels, are explainable as a result of irritation of the periarterial sympathetic nerves. Matas has observed temporary obliteration of the pulse distal to aneurism in cases which at operation showed a patulous lumen of the artery throughout.¹⁹

We have not seen records in the literature in which surgeons gave up hope of restoring the circulation and performed amputation solely because the pulse in the artery distal to the point of operation failed to appear in the first few hours or even days following operation. There are many cases recorded in which the peripheral arterial pulse was days or even weeks in appearing and yet no gangrene occurred. In the case herein reported, the pulse in the popliteal and vessels of the foot are not palpable for months after ligation and there is no sign of ischæmia. It seems that failure of the test of collateral circulation by this means would hardly lead the average surgeon to fail to give his patient the benefit of whatever results might accrue from operations upon the blood-vessels before proceeding to amputate. At the present time, however, can it be said that operations upon blood-vessels should ever be postponed or abandoned because of the negative test of collateral circulation or should the type of operation be determined by these tests?

When, however, the extremity is cold and pulseless and especially if it is insensitive to pain or immobile as the result of extensive injury involving the main arterial trunk of many hours' duration and complicated by extensive bone and joint injury, which are either certainly or almost certainly the seat of extensive infection, it would seem to be standard practice to perform amputation at once.

A question of great practical importance in dealing with injuries of large arteries concerns the exact location for the incision. One may assume now that in dealing with any wound in which infection is present the seat of operation should be reached through clean healthy tissue, the surgical approach. For control of the circulation during operation upon injured arteries this implies that the incision should be made through uncontaminated skin and tissue at

a reasonable distance proximocardial to the wound. Gentle pressure over the wound prevents hemorrhage incident to a clean approach to the vessels. When the vessels are exposed the next question involves temporary control of circulation by the use of clamps or ligatures. Digital pressure may be reliable enough but fingers occupy much space and are more useful for other purposes. Various clamps have been of great use while operating upon the femoral, popliteal and the axillary arteries; but do they possess sufficient advantage over the usual silk, catgut or tape ligature in the case of the external iliac which is quite deeply imbedded, intimately adherent to its surrounding sheath and the muscles and fascia in this location? Is it wise to disinter this deeply placed vessel to the extent necessary to employ clamps or had the circulation better be controlled by means of ligatures, which can be adequately placed while the vessels remain *in situ* without denudation and without traction and disturbance of the surrounding tissues? After the temporary ligatures have been placed and the circulation adequately controlled, it seems quite fair to assume that all the wounded tissue in the region, inclusive of the ragged edges of the wound of the vessels, should be cleanly and adequately excised by sharp knife dissection. With the well-known dangers of infected blood-vessels, such as secondary hemorrhage and clot formation, it would seem that excision of devitalized tissue should be complete, even though it may be necessary to excise as much as to result in a resection of the vessels involved. There is ample ground for the belief that all cases of thrombosis are due to infection, and without infection, even in vessels of small calibre, thrombosis does not occur following either a proper suture or total occlusive ligation. There is further reason to believe that in the absence of infection, gangrene is never caused solely by ligation of any part of the external iliac or femoral at a point above its communication with the sciatic through the branches of the profunda femoris.

The next question which presents itself when one is forced to ligate the iliac above its deep epigastric and circumflex iliac branches is: should these branches also be ligated? In dealing with arteriovenous aneurism of long standing or with a lesion from a recent wound of the vessels, and in dealing with ordinary aneurism of the artery itself, Halsted's teaching, based upon the sound reason which this eminent surgeon always has for everything, gives us ample reason for ligating these vessels when for aneurism the parent trunk is ligated above and below. The branches of the external iliac were not deliberately ligated in the case herewith reported. The pulsation in both these vessels was seen before the external iliac was ligated and it was not detected after the ligatures were made tight.

The next question after adequate *débridement* has been performed and the wound is clean, involves whether *to suture or ligate the vessels*. In this case more than half the vessel walls were destroyed by the wound and lateral suture would have been, in my judgment, impracticable. End-to-end anastomosis would have been possible both of the artery and of the vein. A defect of slightly more than an inch would have had to be bridged over

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by traction upon the ends of the arteries or by grafting a segment of vein between the arterial ends. Realizing my own limitations, I felt much chagrined that I was not sufficiently skilful to make a successful end-to-end anastomosis.

The practical point, however, still to be determined in dealing with wounds of the femoral artery and vein involves this very question. There is reasonable doubt of the preference over quadruple ligation and extirpation, of end-to-end anastomosis, or vein graft for repair of a defect in the common femoral artery necessitating extensive disinterment of the artery and freeing it from its bed for a sufficient extent to bring the ends into apposition without tension. Such extensive freeing of the ends of divided nerves is quite proper, but is it safe to employ the same practice in dealing with divided arteries?

Summing up the evidence as I am able to interpret it from the experimental work and clinical observations, there is basis for the belief that end-to-end anastomosis and vein graft may be preferable in the popliteal following ligation of which gangrene is not uncommon, but in the case of the external iliac or common femoral it remains to be proven that quadruple ligation and extirpation in the absence of infection is ever followed by gangrene.

The literature on the subject is too full of uninterrupted recoveries following ligation of these vessels in cases in which wound infection could take no part; and gangrene following ligation is so rare even in cases in which infection was present, that it is not easy for one to believe that either vein graft or disinterment for relief of tension preliminary to end-to-end anastomosis can be preferable.

It is definitely proven that aseptic ligation is *not* followed by thrombosis.^{16, 17} It cannot be questioned that skilful suture is often followed by thrombosis. No one can predict if thrombosis does occur how long the thrombus may be; and a long thrombus extending up and down the lumen to branches may defeat the purpose of suture and result in gangrene. Surgeons have opened the external iliac artery deliberately and removed clots to prevent or cure incipient gangrene. Leakage through suture holes can be detected only after completion of suture and removal of temporary occlusion. Any case of sutured vessel from which leakage occurs is extremely likely to be followed by thrombosis and may be the cause of perivascular haematoma with all the pernicious effects of haematoma formation in favoring inflammation and causing pressure upon the main vessel and other arteries (potent factors in causing gangrene). The clinical, the experimental, and the logical evidence at the present moment certainly offers much support to the belief that for arterio-venous fistula involving the common femoral or external iliac vessels occlusive quadruple ligation of artery and vein with extirpation of the lesion through an incision giving a clean surgical approach to the field of operation is quite preferable to the most expert suture of the vessels through damaged and contaminated if not infected tissue.

And finally the question arises *when it becomes necessary to ligate an artery should the corresponding vein also be ligated even though it is not*

injured? This question, of course, does not enter into the case here reported because the vein was also extensively injured. French surgeons and Makens, of England,^{5, 18} advocate simultaneous ligation of the vein when it is necessary to ligate the artery even though the vein is not injured. Lee,¹⁴ however, working at the American hospital at Neuilly, reports eight consecutive cases of ligation of the femoral artery alone in Hunter's canal for popliteal injury and all the cases were successful. Neuhoff and St. John¹⁰ believe the vein should be ligated to prevent phlebitis, and state that it is definitely determined that after vein ligation there is less danger of gangrene. Surely every surgeon would agree now that in case of injury of the femoral artery and vein no effort should be made to preserve the lumen of the vein. Halsted¹⁸ quotes the investigation of Drummond upon this subject in the case of the vessels in the viscera and refers to the work of Welch and Mall on "intestinal infarction" (soon to be published). Bowel strangulation by ligature of the artery only, invariably shows more serious change than after simultaneous ligation of both artery and vein. At Halsted's¹⁸ suggestion Hooker made some interesting observations upon the blood-pressure in the branches of the femoral artery. After ligature of the artery alone there was an immediate fall of pressure from 114 to 20 mm. Within an hour's time the pressure rose to about 50 mm. (Was this the result of dilatation due to periarterial sympathetic paralysis?) When pressure was made upon the main venous trunk there occurred an immediate rise of pressure in the artery sometimes as much as 20 mm. of mercury. The test for several hours gave uniformly similar results.

Halsted¹⁸ states: "We are compelled, I believe, to subscribe to the view that some degree of equilibrium of the arterial and venous systems must be maintained. Granting this, there vanishes any difficulty that there may have been in accounting for the very high percentages of gangrene observed to follow ligation of the artery in cases of arteriovenous fistula. There is in these cases not only a great enlargement of the venous bed but also a curtailment of the arterial tubage—a shrinkage or hypoplasia of the arteries distal to the fistula. Thus even before the artery is ligated the limb is handicapped by this lack of balance. When, now, the artery above a fistula is tied, irrigation with arterial blood is suppressed on one side of the capillary bed and on the other side of it the mixed blood is deprived of a share of the pressure by virtue of which the life of the limb was partly sustained. It seems permissible to conjecture that in some instances the limb distal to the fistula may have been hardly less dependent on the pressure from the venous than from the arterial side, and if so we can more readily comprehend the ensuing gangrene than the frequent absence of it after ligation of the fistulated artery."

The clinical obesrvations made especially by the English and French surgeons during the war⁵ that after ligation of the large arterial trunk in the extremity, gangrene was less likely to result if the companion vein was also ligated, is easily explained by the demonstration of Hooker that catabolic substances such as are contained in the venous blood cause dilatation of the capillary bed. Though, of course, highly toxic substances permanently re-

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tained would be undesirable, the great abundance and interinosculation of veins in the extremities makes it quite impossible to retain venous blood for a great length of time by ligation of even the largest vein. The common-sense suggestion occurs that if the blood entering the limb is diminished or cut off entirely, we should at least be sufficiently considerate of the tissues to tie the vein and permit what will of the blood surely containing some food to remain. There is genuine reason for believing that vein ligation favors the development of collateral vessels, and through retention of blood volume and pressure aids enlargement of vessels already present.

As to material, silk, catgut, fascia or linen tape, we are not able to get from recorded cases definite and positive proof of the best by test. In the case here recorded we used chromic catgut No. 2 doubled, and though I know of no reason to regret it in this case, I shall, if I have to deal with a similar injury again, follow Halsted's advice and employ coarse silk.

I wish in this case we had more completely extirpated the injured portion of the vessels. Callander's cases¹⁹ of recorded arteriovenous aneurism show 100 per cent. of efficiency of this method of treatment. In the case herein reported we accomplished almost complete extirpation of the vessel walls between ligatures through *débridement*.

In this case we placed in the wound for three days a strip of flat rubber to provide exit for possible oozing. There should be no possibility of post-operative oozing in any case of blood-vessel surgery—the wound should be completely closed, perfectly dry, and the dressing applied in such a manner as to secure complete immobilization for a few days. Packing and pressure are pernicious practices.

Observations made upon injured blood-vessels have added much of practical value to the study of physiology of the circulation and will explain many phenomena which have been commonly observed and heretofore unexplainable. Wounds of large arteries are invariably followed, at least for a few hours, by contraction of the artery for some distance below the wound and cessation of pulsation. This might account for the clinical observation that frequently with wounds even of some size in a large arterial trunk, there may be no bleeding for several hours. In wounds of large arteries, even independent of arteriovenous fistula, bleeding is often so small in quantity that the war surgeons spoke of them as "dry wounds" of arteries. It has also been a common observation, both by experimentalists and surgeons operating upon blood-vessels in human beings, that during the manipulations of an artery incident to operation, the vessel for a considerable distance, if not throughout its entire extent below, becomes contracted down to perhaps half of its original size. Following this period of contraction, after several hours there occurs dilatation, during which there will be increased flow of blood into the artery, as shown by various instruments for detecting blood-pressure and temperature. Preliminary contraction and reactionary dilatation are readily explainable upon the effect of irritation and destruction of the periarterial sympathetic nerves. Irritation of these gives contraction; destruction results in

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dilatation or vasomotor paresis. Dilatation of the capillaries preceded by preliminary contraction invariably occurs when the vasomotor nerves of the arterial trunk or of the capillaries are destroyed. The capillary bed, when dilated by vasomotor paralysis or by toxic substances in the blood, favors blood retention and thus tends to keep open and full of blood the capillary spaces for tissue nutrition.

The significance of the periarterial sympathetic nerve-fibres may prove useful to explain certain phenomena referable to the symptoms and signs produced by arterial injuries and may have a wide influence in determining the time for and method of operative treatment. W. S. Halsted¹⁸ has exhibited interest in this subject and will doubtless eventually give us much specific information. Injury to the wall of the arteries seems invariably to be followed by spastic contraction of the artery for a variable distance peripherally. This may account for the fact often observed that wounds of large arteries often remain "dry" for six or eight hours. During this period of arterial contraction at which time the distal pulse is obliterated by spasm there is liability to error in believing that the artery is occluded and the extremity in danger of gangrene. Following the period of spastic contraction there occurs wide arterial and capillary dilatation with hyperæmia of the part, increased local temperature and other reactionary phenomena. From these facts would it not seem quite wise in dry wounds of arteries to wait for the subsidence of contraction from periarterial sympathetic nerve irritation before operation for such an injury? There are other causes for dry wounds of arteries and veins. The blood may flow from the artery directly into the vein and consequently not escape in the form of systemic hemorrhage. The patient bleeds into his own vein, the tissues distal to the injury are ischaemic. Wounds may be dry, therefore, though this constitutes no positive evidence that the artery has not been injured. The peripheral pulse may be entirely obliterated, and this is not positive evidence that the lumen of the artery is occluded, or that the vessel is completely severed. Both these phenomena may be due to periarterial sympathetic irritation.

These phenomena may account for many cases recorded in literature in which, on account of failure to detect the pulse in the feet and hands, it was assumed that the artery was blocked by thrombus. Pulseless and cold hands and feet may not necessarily, therefore, be regarded as doomed to gangrene. Failure of return of the peripheral pulse within a period of eight hours after injury or operation constitutes no reason for grave anxiety. Later than this the presence of vascular dilatation due to paresis of the vasomotor mechanism will be of great service in aiding the establishment of circulation. Is it probable that the paralytic vasomotor dilatation may be more complete when the main arterial trunk is boldly ligated and excised than when it is more carefully handled as of necessity it must be for successful suture?

Reading the clinical reports of cases of injury to blood-vessels, one is impressed by the great variability of the character of observations made. There are many records of injury to the femoral and popliteal arteries fol-

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lowed immediately by absence of pulsation in the dorsalis pedis or of one of the tibial arteries for a few hours following injury, and later a return of pulsation and circulation perhaps independent of any operation or any treatment. The special importance of the knowledge of this effect of arterial sympathetic irritation and destruction has to do with certain of our interpretations with reference especially to the testing of collateral circulation before operation and of the assumption which we are likely to make that this natural subsidence of arterial contraction resulting in dilatation and restoration of the pulse wave is a result of treatment. It is conceivable that the return of the pulse in the dorsalis pedis might follow ligation of some artery in the region of a large trunk like the iliac or femoral, and which during the surgeon's distress at the sight of such a hemorrhage, he may have thought was the large vessel itself. Suppose, for example, during an operation for hernia an amateur surgeon should cut one of the epigastric or circumflex iliac branches of the great arterial trunk, he would be excusable if during the stress of the situation, the volume of blood looked like enough to have come from the femoral, and then immediately after tying the smaller artery, though perhaps with some trauma to the parent trunk, he should find an hour or so later that the pulse in the dorsalis pedis was not palpable, it would not necessarily follow that he had tied the femoral artery. Moreover, a return of pulsation in the foot and ankle arteries as promptly as a few hours after the ligation would not necessarily indicate the establishment of collateral circulation. If looked at critically, such phenomena would lead one to believe that it was not the femoral but some other artery which had been ligated. A few hours is ample for the return of pulsation coincident upon the reactionary dilatation following periarterial sympathetic irritation, but it is not possible to reestablish collateral circulation sufficient to cause pulsation of the dorsalis pedis within a few hours after ligation of the common femoral. In the case herewith recorded pulsation of the vessels in the foot, nor even of the popliteal, can be detected, and it has been six months since the iliac was ligated. There is abundance of blood in the limb, the superficial veins are full, though not markedly distended, and the patient knows no difference in the sensations and usefulness of the injured from those in the uninjured extremity.

Collateral Circulation.—Next to the saving of life through the prevention of hemorrhage, one has hopes of saving the limb through the prevention of gangrene. If the external iliac artery is deliberately ligated, or if following suture it becomes accidentally occluded by clot formation, will the tissues in the limb distal to the point of occlusion receive nutrition, and if so how? Authors speak of collateral circulation through anastomosis of arteries. They say that after ligation of the external iliac artery the collateral circulation is carried on by anastomosis of the branches above the point of ligation of the main artery with the branches of the parent trunk below the point of occlusion. From these statements we are led to believe that the branches of the artery above actually become united to and communicate with the branches of the arteries below. Does this mean that the blood passes directly from the distal

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end of an artery above into the distal end of an artery below and then pursues its course in reversal to the normal physiologic course of blood in arteries back to the parent trunk? Diagrams illustrating this method of connecting up arteries and reversal of arterial circulation are pictured in many text-books. Must we believe in such a distortion of normal physiology? It has been repeatedly demonstrated by Horsley,^{21, 22} Stetten⁸ and other investigators that reversal of circulation of blood from arteries to veins does not occur. It does not seem reasonable for us to believe that blood can pass from one artery through the capillaries back into the arterial capillaries and then in a reverse direction through another artery. This question might be answered by experiments in a living animal, although I can find no record of it having been done. On the other hand, it is quite demonstrable that those arteries constituting the posterior branches of the aorta do actually communicate with arteries having a location anteriorly, and this union results in forming arterial loops. Illustrations of this loop formation are noted in many places. The posterior intercostals actually communicate with the anterior intercostals, and when an intercostal is cut bleeding occurs from both ends. Such a vascular loop is also formed by the right and left gastroepiploic artery on the greater curvature of the stomach, and with the uterine and ovarian artery forming the arterial loop of Byron Robinson, and is the method of formation of arterial arches in the feet and hands. Arteries communicating with arteries results in formation of vascular loops around the bowel, is seen on the outer aspect of the dura mater, and is the actual cause of the formation of the circle of Willis.

It is well known that the ligation of one internal iliac artery will not curtail the amount of blood going to the uterus and other organs supplied by these vessels. This is clinical evidence of the probable existence of arterial loop formation by the terminal junction of the uterine arteries. When it is remembered that the internal iliacs are the continuation of the common iliacs and that these are homologous with the lumbar and intercostal arteries, this loop formation by inosculation is exactly what we would expect. The disappointment caused by failure of ligation of both internal iliacs and both ovarian arteries to cause starvation of uterine cancer is incident to the fact that this organ receives blood also from branches coming from the external iliac and inferior mesenteric arteries and other sources. To strangulate the stomach by ligation of the celiac axis or the small bowel by ligation or thrombosis of the superior mesenteric is easy enough. These arteries, the sole source of blood to the parts supplied, are anterior branches of the aorta. But to produce total ischaemia by single ligation of a dorsal segmental branch of the aorta is a different proposition because of the normal inosculation of these with each other through communicating branches of the arteries of different segments and because of their communication with their own anterior portions. The posterior branches of the dorsal intercostals and lumbars communicate above and below the point of total occlusion of the abdominal aorta. The reason for efficient circulation through the communication of the superior epigastric from

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above and the inferior epigastric from below is easily comprehended. These vessels represent essentially the terminations of dorsal segmental branches of the aorta in embryo; the superior epigastric from the internal mammary (a branch of the subclavian homologous with the posterior intercostals) and the inferior epigastric from the external branch of the common iliac (a greatly enlarged lumbar artery). Both epigastrics, therefore, represent terminations of dorsal segmental branches of the aorta; the superior from the subclavian and the inferior from the common iliac.

With clear-cut distinction of meaning we may, therefore, quite properly speak of inosculation of arteries, by which we mean the terminal ends of two arteries actually communicate forming a loop, and an anastomosis of arteries, by which we understand that terminal branches of various arteries in a given region of the body come intimately in contact with each other, and to the naked eye appear to mix, but in which no blood actually passes from one artery into the other.

It is quite obvious that the large amount of blood brought to various organs and tissues by the abundance of smaller branches from different arterial trunks is adequate to maintain nutritional needs. This fact is demonstrated in every operation where ligatures are employed to check hemorrhage; and by the total failure of so-called "starvation methods" of treating cancer by ligation of incoming vessels. Genuine skepticism concerning the utility of ligation of thyroid arteries for the purpose of diminishing the amount of blood coming to the thyroid gland is well supported by so firm a foundation of elementary anatomy and physiology.

On the other hand, the sudden occlusion of a large artery like the femoral or axillary in cases of great peripheral engorgement due to elephantiasis, or venous blocking by cancer adhesions, may cause temporarily some relief of swelling by temporarily curtailing the amount of inflow; and ligation of both external carotids has likewise caused temporary cessation of pulsation of circoid aneurism of the scalp.

A true compensatory collateral circulation implies a compensatory enlargement of the normal inosculation of arteries forming a communicating loop when the necessity for this performance is brought about through the imposition of additional function after ligation of one artery forming a part of the loop. Is it true, however, that in parts of the body where such loops are not formed normally, their formation can be brought about by ligation?

It seems that fundamental considerations of normal anatomy would go far toward giving us a satisfactory explanation for the repeatedly observed clinical fact that gangrene should never occur after a single ligation of the aorta or common iliac or internal iliac; that it will never occur after ligation of only one of the arteries forming the arches in the feet and hands, nor of the intercostals nor of certain other vessels having such a normal communication with each other by inosculation. The clinical observation that gangrene frequently occurs after ligation of the popliteal artery is explainable when we remember that there is often no companion artery with which the popliteal or its branches

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can communicate through inosculation. But for the persistence of a patent portion of the primitive popliteal, anterior to the popliteus muscle (its embryonic location) and the possibility of establishing communication between this and one of the tibials or peroneal below, total ischaemia might always result from occlusion of the popliteal.

The explanation of the method of formation of collateral arteries must of fundamental necessity take into consideration the original mode of formation of these vessels in embryo; and of the part played by the physiology of these structures in relation to their formation; and of the physiology of blood-vessels in adults. In this way we may find it possible to explain certain clinically unexplainable phenomena and aid may be secured in the explanation of certain phenomena at the present time constituting obscure problems incident to blood-vessel surgery. This constitutes a large field for speculation, and some philosophical mind like that of W. S. Halsted should be able to put together the various scientific facts and give us a basis upon which to act intelligently in the practice of clinical surgery.

The origin of blood-vessels in embryo is independent of the origin of the heart. The first blood-vessels in embryo are formed in the periphery and actually antedate in point of time the appearance of the embryonic heart. The origin of blood-vessels constitutes no exception to the fundamental biologic laws enunciated by Roux, Thoma and others that they are the product of tissue needs.^{3, 4} In other words function fixes form; physiology is the cause of anatomy. Capillaries are the product of specific cells designated "angio-blasts." The capillaries are not formed as a result of the blood-stream; they antedate the stream stage of the circulation. The development of capillaries is in response to tissue needs for the passage of food and effete material. After, however, the formation of the heart and the communication is established by capillaries with the arteries and veins, the further development of these structures is markedly influenced by the volume of blood, perhaps the blood-pressure and by the function of the vessels in effecting the transportation and interchange of nutritional and effete material to and from the tissue cells. To facilitate this function there must of necessity develop a complicated physiologic mechanism.

As factors in the dynamics of the circulation Hooker⁵⁰ has clearly demonstrated the great importance of capillaries and venules. The findings of this physiologist are of great practical importance in explanation of the development of collateral branches or the substitution of function of one artery for another when one becomes occluded and in demonstrating the chemical and nervous mechanism controlling the dynamic influences of the capillary bed. He has shown that oxygen, adrenalin and other food substances cause contraction, while CO₂, lactic acid, histamine, and other catabolic substances cause great dilatation of the capillaries. Of great importance was his remarkable observation that after the death of the animal there regularly occurs alternate contraction and dilatation of the capillaries, reciprocally with the venules. In this way blood was passed from capillaries into venules and from venules

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back into capillaries. But not in a single instance was the blood observed to be carried from the capillaries into an arteriole. The capillary constriction was seen to sweep blood in a peristaltic fashion from the capillaries into the venules during a period of fifteen minutes or more, after which a remarkable relaxation of the venous side occurs, the capillaries again becoming filled by blood flowing from the venules; this stage lasts forty-five minutes or more. Finally, coincidentally with rigor mortis, capillary contraction occurs and they remain empty. This is the beginning of gangrene. These remarkable phenomena were shown to be controlled by chemical substances and a nervous mechanism and constitute the major process by which extensive capillary areas may be emptied and packed with blood and plasma passed into and out of the tissue spaces.

Further observation illustrated the difference between the behavior of capillaries related to arteries which communicate directly with each other through inosculation. After ligation of the carotid artery and the vessels of the omentum, preliminary contraction did occur. Hooker's explanation of the capillary contraction is that it results from asphyxia. Asphyxia does not occur in tissues supplied by arteries which actually inoscultate with each other unless all the arteries involved are tied. In other arteries the branches of which do not inoscultate but merely anastomose, ligation is ample cause for asphyxia. The physiologic needs of the cells distal to ligation take active part in causing the remaining arteries to bring more blood and causing both the increased calibre of already existing arterial branches and the formation of new branches adjacent to the point of arterial occlusion. And finally of great importance in its bearing upon occlusion of arteries is the fact that tissue needs may result in reestablishment of function and of patency to arteries which, though atrophic and hypoplastic in post-natal life, played a great part in physiologic action and were arteries of large size in the period of development. The application of this fact to the problems of the route of blood transportation after ligation of the femoral or external iliac artery would lead us to predict with a belief close to certainty that the circulation would be brought about through the reestablishment of communication through the sciatic artery and its inosculation with the deep femoral through the perforating branches. This area of arterial inosculation is developed from Senior's² plexus of communication between these vessels in embryo.

The researches of Senior^{1, 2} published in 1919-1920 upon the embryology of the arteries of the lower extremity have resulted in the discovery of facts of great value in their practical application to the question of the mode of rerouting blood circulation or of the substitution of function of one artery when as a result of ligation another artery is rendered functionless.

The work of Senior^{1, 2} and of Hooker³⁰ when studied together are capable of throwing much light on the explanation of the maintenance of circulation in the area distal to the application of the ligature. And it will be interesting when the reports of vessel ligation are tabulated, to note the conformity of results obtained in practice, with those which could have been anticipated

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through a comprehension of the origin, development and function of the blood-vessels and the application to clinical surgery of the basic laws of biology.

It has been known for many years that in early embryonic life the arterial supply to the lower extremity was through an artery called the axial, the uppermost remains of which in the adult, is the sciatic. The external iliac-femoral artery does not exist in the earlier stages of embryonic life, but is a later development from the embryonic umbilical artery which in the mature foetus is the common iliac. Though the deep epigastric artery is apparently a branch of the external iliac, there are evidences of formation of the epigastric at the earlier period in the life of the embryo than of the formation of the external iliac. Somewhat later the common femoral divides into two terminal branches, one of which, the saphenous, becomes the superficial femoral, the other persists as the profunda femoris. The femoral artery, therefore, though a later product than the primitive sciatic, grows with much greater rapidity and to a much larger size.

Almost coincident with the division of the primitive femoral into its two branches, there develops from the primitive sciatic which at this stage of the embryo is called the ischiadic portion of the axial artery (reaching all the way down the extremity to its terminal plexus in the foot) a recurrent branch called the rami communicantes. This grows upward toward the developing femoral and ends in a distinct plexus called by Senior the rete femorale. In this collection of terminal arterial capillaries at least a portion of the blood-stream passes directly through this communicating plexus of Senior to and from the femoral and the axial arteries, though a part of the blood is also drained to the venules in the usual way.

In the embryo Senior² has shown that the plexiform arrangement between the terminal branches of the rami communicantes from the axial and the terminal portion of the femoral actually exists. He has not been able, however, to demonstrate such a plexus arrangement in any other portion of the lower extremity except the portion of the artery ending in the foot and which represents ultimately the arch formations. Even around the knee he was unable to demonstrate this plexiform arrangement. The plexuses, however, are certainly demonstrable in the region of the communication between the sciatic and the femoral.

As the femoral grows downward it comes in contact with the axial and seems to take possession of this vessel. Passing on downward the portion of the axial just above the communication with the femoral becomes smaller and ultimately is indistinct. The upper portion remains as the adult sciatic. The portion of the axial below the connection with the growing femoral remains and is represented by the popliteal. This divides in the process of development of the leg into three adult arteries, the anterior and posterior tibial and the peroneal. Thus it is clear from the standpoint of embryology that in the upper part of the thigh there are two main arterial trunks, the external iliac-femoral and the sciatic; in the region of the knee the popliteal is the sole arterial supply and below this there are three vessels. It would

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follow from this that the most dangerous vessel in the lower extremity for ligation, so far as future blood supply is concerned, is the popliteal; and this conforms to clinical experience.

In the early embryo the part of the axial remaining as the popliteal is located anterior to the popliteus muscle. As a result of the development of this muscle, the popliteal artery becomes posterior to the muscle, though with some frequency the primitive popliteal remains as a patent branch located between the muscle and the knee-joint and gives rise to the anomaly of a double or accessory popliteal artery. Can it be that this anomaly can account for the fact that gangrene does not result from every case of ligation of the popliteal artery?

Are we justified in the belief, therefore, that the collateral circulation brought about by the ligation of a large arterial trunk occurs in a simple unphysiologic method by which it is described by most authors, or must we readjust our views to conform to the laws of development which operate in the embryo and are obeyed when the functional necessity for such blood circulation is brought about artificially either through surgical ligation, accidental injury, or arterial thrombosis?

There is opportunity for some qualified and equipped investigator to make an experimental study of this question. We will predict that biologic laws will be obeyed and that after ligation the circulation of the blood reverts to the vessels through which it circulated in embryo. The function of the common femoral, or external iliac artery when this vessel is tied, may reasonably be expected to be taken by the sciatic, provided, of course, the arteries and the individual are not as ancient as to be incapable of taking on additional function and performing extra laborious work. If any case of gangrene has ever been conclusively shown to be the result of aseptic ligation solely of the common femoral or external iliac vessels on account of a wound of even moderate recency, the case report is not easily accessible.

A remarkable case reported by Neuhoff and St. John¹⁰ records the following ligations after an extensive war injury of the thigh. The femoral artery had been ligated immediately; following this, as a result of infection, there were eleven hemorrhages; on the twenty-third day the femoral vein was ligated; and on the thirty-fourth day the external circumflex (?) was ligated and on the same day the femoral artery was re-ligated; on the fiftieth day the profunda femoris (?) was ligated; on the eightieth day the profunda femoris (?) was re-ligated; and finally through a clean surgical approach the external iliac artery was ligated, and five weeks later the wound was healed without gangrene and the patient was discharged as out of all danger of gangrene and with cure of the infection.

It will be noted that the report does not state with absolute certainty that the profunda femoris was ligated; it was thought to have been done twice, once on the fiftieth day and once on the eightieth day. It is quite certain that the sciatic and its parent trunk, the internal iliac, were not occluded. This case is instructive. There is room for speculation. Did the interval of at

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least forty-five days before the first ligation of the profunda femoris and of thirty-four days before the second ligation of this vessel permit the collateral circulation through the sciatic to become well established? It will also be noted that on the twenty-third day a large vein, "probably the femoral," was ligated. Was this also influential in prevention of gangrene?

The case is a remarkable demonstration not only of the effects of infection in causing secondary hemorrhage and of the immediately satisfactory result of ligation of the external iliac artery through a separate incision through non-contaminated tissue, the "surgical approach," but goes a long way toward illustrating clinically what we would expect biologically: that after occlusion of the external iliac the blood reaches the periphery through the same vessel it did in embryo, the sciatic artery. Will not some one make experimental test of this theory and determine whether or not, in response to functional needs, the sciatic-femoral communication of the embryo becomes reestablished or whether in obedience to the law of growth the sciatic becomes sufficiently elongated and enlarged to substitute successfully the function of the femoral for blood transportation?

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PRELIMINARY LIGATION OF COMMON ILIAC ARTERY IN HIP-JOINT EXARTICULATION*

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ONE cannot seriously contemplate exarticulation of the hip without developing an acute interest in the experience of those who have preceded him. When it is to be combined with a preliminary ligation of the common iliac one's interest is naturally increased. There have been too few of the double operations successfully completed to have clearly paved the way for its routine application, and that more light may be shed on the procedure a brief reference to the valiant and instructive efforts of these pioneers may lend interest to the study.

Hip Amputation.—Now and then, there appears in the medical firmament a man with an idea endowed with the persistence necessary to enforce its development and recognition. Such a man was Morand. In 1729, fifty years before the idea was put into actual practice, before the Royal Academy of Surgery of Paris, he represented amputation through the hip-joint as not only possible, but practical. As is usual, when departure from the beaten path of experience and empiricism is advised, the promoter is condemned as a radical and he is shamed into silence; but not so with Morand. After a decade of waiting, through the medium of two of his followers, a thesis was presented to the Academy, describing in detail the operative procedure and reiterating his belief in its justice and practicability. It was promptly and unanimously rejected. In 1756, he succeeded in having the subject discussed in a prize essay and twelve responded, all of which met the same fate at the hands of the men of science. Finally, three years later, with admirable faith in his convictions, he was again able to secure the presentation of the subject in a prize essay. Of thirty-four contestants, nineteen favored the procedure, and a defender of the operation, Barbett, was awarded the prize. Morand died before an amputation was attempted, yet one must assume that his satisfaction in the acknowledgment of the feasibility of his radical suggestion, brought well-deserved solace to his final days.

Kerr, of Southampton, records the first completed attempt at hip amputation, in 1774, and although he inadvisedly performed it on a tuberculous hip, the fact that the patient lived fifteen days clearly refuted the contention that immediate death would follow, and lent courage to those who had occasion to attempt it later. During the Napoleonic period, it was applied in military surgery and at least two survivals are recorded, at the hands of Lorrey, the Emperor's noted

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surgeon. Since that time, with the gradual improvement in surgical technic, antisepsis and asepsis and a clearer knowledge of the indications for hip-joint amputation, many successes have resulted in both civil and military practice.

The unusually high mortality following removal of one-fifth the body weight, especially under the unfavorable circumstances that invariably attend the act, should justify this report. In so far as our information serves us, but few previous reports have been made of premeditated permanent transperitoneal ligation of the common iliac as a preliminary step to exarticulation at the hip-joint. A recent case was attended by Barney Brooks, of St. Louis, and will be referred to later. Halstead's admirable "Review and Report upon the Effect of Ligation of the Common Iliac Artery on the Circulation and Function of the Lower Extremities" furnishes convincing proof of the ability of the collateral circulation to continue the necessary blood supply to the limb. Thus is removed any uncertainty as to subsequent viability of the stump in hip disarticulation, provided the anastomotic circle is not broken by disease of the blood-vessels themselves. It is obvious that in so brief a discussion all reference to the etiology and pathology of the conditions necessitating this operation must be omitted.

In reviewing the opinions of various authors as to the actual cause of the high mortality, loss of blood stands paramount. One does not ignore the fact that in the majority of instances where the operation is indicated, the resistance of the patient has been broken and his vitality undermined by long-continued disease, or has been weakened by severe trauma, hemorrhage, or sepsis. It would, therefore, seem incumbent upon us in our search for an effective check to the high per cent. of fatalities to directly attack the causes that contribute so generously. In the order of their importance these factors are hemorrhage, shock, and sepsis. Shock is so closely related to hemorrhage that a concise definition is impossible. Its prevention, control, and relief are so dependent upon the pre-operative precautions, operative technic, and post-operative care, that further discussion here would seem ill advised. Sepsis, since a knowledge of its prevention has become general, has been the accepted cause of death in so small a number of cases that it may be dismissed as an unimportant factor. When death follows so formidable a procedure from shock, hemorrhage, or both combined, it occurs before serious infection has time to make itself known, even though it were present to an alarming degree.

There are but rare occasions when hip-joint disarticulation is so immediately imperative that primary blood loss and shock from the original trauma cannot be eliminated before operation. The blood picture may be improved and the stability of the patient reestablished until sufficiently fortified to withstand an ordinary amount of shock and hemorrhage, and the operation can proceed by any ordinary method with a fair assurance of success. Under such conditions any of the various forms of

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tourniquet control that can be applied and held sufficiently high to give ready access to the hip-joint structure should be acceptable. Prevention of tourniquet displacement was cleverly accomplished by Wyeth with the aid of transfixion pins. His greatly improved method, familiar to all, will satisfy all ordinary demands and in the great majority of instances is the safest and most effective. Similar control of the tourniquet is obtained by Deaver and others with retraction bandages over the opposite shoulder or supported by an assistant. Senn exposed the femur by a lateral long-axis incision and by blunt dissection, posterior to the adductor group, insinuated a double elastic, thus constricted the two halves separately, leaving the femur free for removal. Each of these and other similar methods have the disadvantage of preventing free access to the pelvic girdle attachment of the muscles of the thigh that as a future source of danger it may be desirable to totally resect. In obese patients the deep vessels are sometimes controlled with difficulty and the general oozing seemingly insignificant may endanger the balance of power when the margin of safety is slender, and should not be considered negligible. Wyeth, after ligating the femoral, obturator, sciatic, external and internal circumflex, very properly remarks: "If every oozing point were ligated, from one-half hour to an hour would be consumed in securing a dry wound in the majority of cases." This oozing he controls by quilting the muscles of the stump. He reports sixty-nine cases operated by his method with a mortality of 15.9, a most flattering decrease from the day of Walter Brashaer, whose hip disarticulation in 1806 is the first on record in this country. As described by Prof. D. Y. Yandel in "American Practitioner and News, 1890," Brashear "made a circular incision, divided the muscles well below the hip-joint, securing the vessels as the operation progressed. A longitudinal incision along the outer side of the limb exposed the remainder of the bone, which being freed from its muscular attachments was disarticulated at the socket." This is evidence of how little our technic has improved in the last century, as well as a tribute to the intrepidity of the Kentuckian. In 1881 Prof. John Ashurst, Jr., wrote: "A removal of the lower limb at the coxofemoral articulation may be properly regarded as the gravest operation that the surgeon is ever called upon to perform, and it is only within a comparatively recent period that it has been accepted as a justifiable procedure. The most pressing risk is that of hemorrhage."

Circular No. 7, War Department, S. G. O., 1867, publishes a most impressive report on "Amputations at the Hip-joint in Military Surgery," presented by Lt. Col. Geo. A. Otis, at the request of Surgeon General Barnes. Fifty-three instances of hip-joint amputation are rehearsed in detail. He reviews in most interesting fashion the history of hip-joint exarticulation down to his period.

He cites 108 amputations for gunshot injuries up to the time of the Civil War, of which ten recovered, a mortality of 91.6 per cent.; 111 hip-joint amputations in civil practice with forty-six recoveries,

a mortality of 58.5 per cent. Otis ascribes the cause of death to "shock to the system, secondarily to hemorrhage, primary and secondary, and to sepsis." The external iliac was easily controlled in most instances, the greater danger coming from the branches of the internal iliac. Consequently aortic pressure of many types was tried from the illogical 24-inch intrarectal wooden compressor of Davey, to digital or fist compression of the femoral and aorta. Secondary hemorrhage was not uncommon, and persistent stump bleeding was the cause of death in several instances.

Preliminary Ligation of the Common Iliac.—The struggle to swing the formidable operation of hip-joint exarticulation toward the safety column has met only with the measure of success one might rightfully expect from improved asepsis and surgical finesse. The death-rate is still too high and the control of hemorrhage and consequent diminution of shock by means that most assuredly do not increase the danger, is a logical aspiration. In the opinion of the writer, preliminary ligation of the common iliac increases to a justifiable degree the element of safety in those cases wherein further loss of blood and augmented shock cannot be tolerated. Such complete control of stump hemorrhage is thus obtained that the application of six to ten haemostats is sufficient to assure a dry field. The muscle planes can be gently approximated with negative tension without fear of oozing, or of threatening the viability of the stump. Considering the ease with which common iliac ligation is accomplished and the added safety promised, one cannot refrain from wondering why we have hesitated for so long to carry out in detail the principle which even though crudely has been attempted in practice for so many years by such worthy surgeons as Esmarch, Mott, Lister and other pioneers, with the aid of various abdominal tourniquets in an attempt to compress the abdominal vessels and thereby diminish the strength of the current to the affected area. Temporary direct pressure of the common iliac in the treatment of aneurism of the pelvis and upper limb has been practiced for many years with varying success. Some of the experiences are so interesting that it is regretted they cannot be recited in detail. Valentine Mott, in 1827, deliberately tied a common iliac artery in an endeavor to cure an iliofemoral aneurism and was successful in that the patient lived and recovered. Professor Halstead, of Johns Hopkins University, in assembling the recorded cases of ligation of the common iliac artery which have been reported since 1880, was a pioneer in attempting to prove that the operation is entirely feasible. He estimates an average of one ligation a year for the last one hundred years, the great majority of the efforts being directed toward the cure of aneurism. Stephen Smith reports all ligations between 1829 and 1859, including one of his own, and states that the indications which have led to the deligation of the primitive iliac artery may be divided as follows: (1) For the arrest of hemorrhage. (2) For the cure of aneurism. (3) For the cure

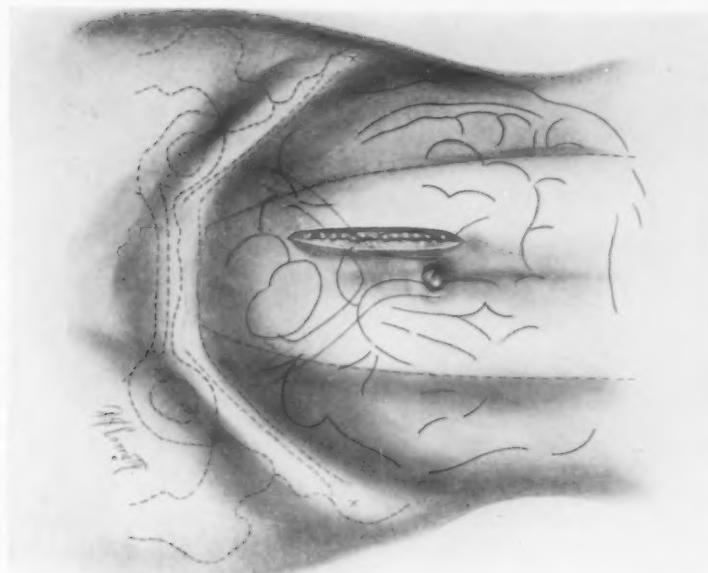


FIG. 2.—Location and relation of ligating incision.



FIG. 3.—Bulging peritoneum between retracted rectus and medium linea, a generous time-saving exposure.

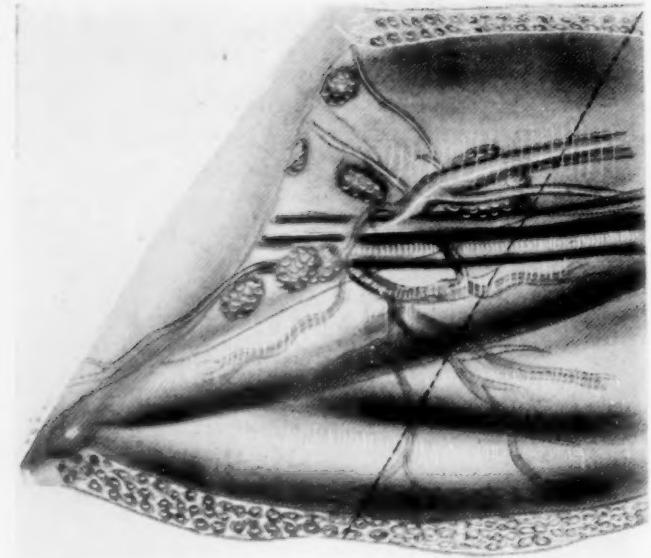


FIG. 5.—Relation of structures at line of skin incision. Inguinal glands and involved muscle groups to be reached through elevation of skin cuff.

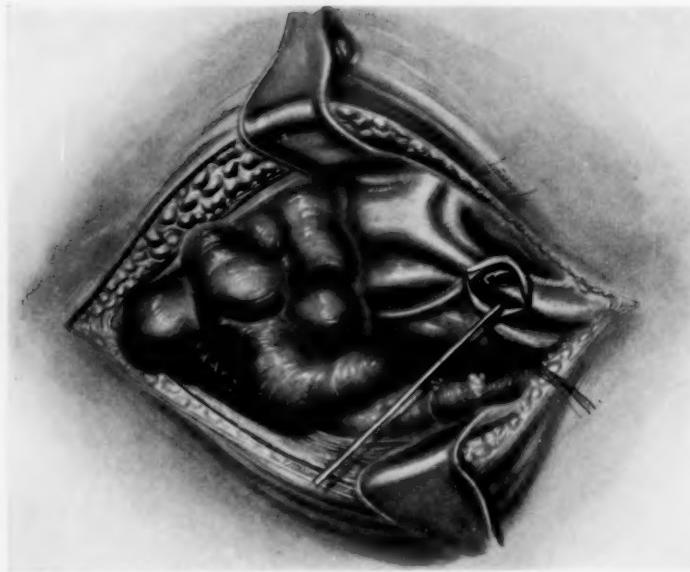


FIG. 4.—Patient in head-down position, intestinal loops elevated, peritoneum divided, ureter pushed aside, and ligature-carrier in position.

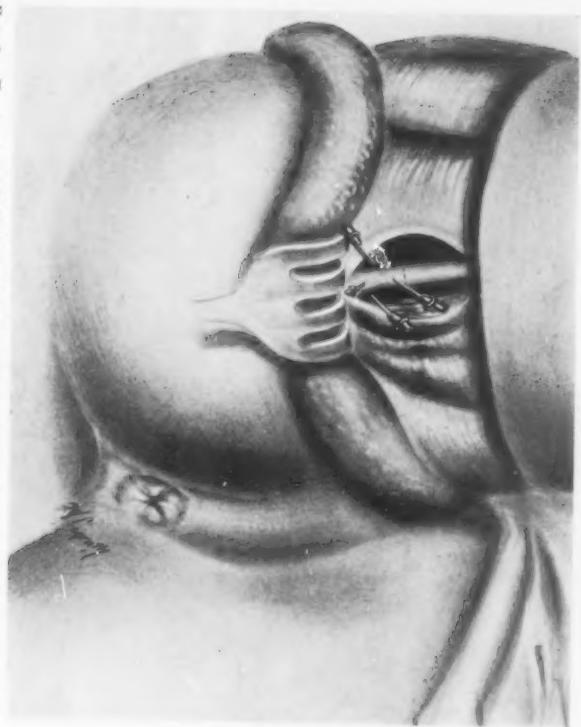


FIG. 6.—Exposure and blocking of sciatic nerve. Alcohol injection between coccygeal area and line of division.

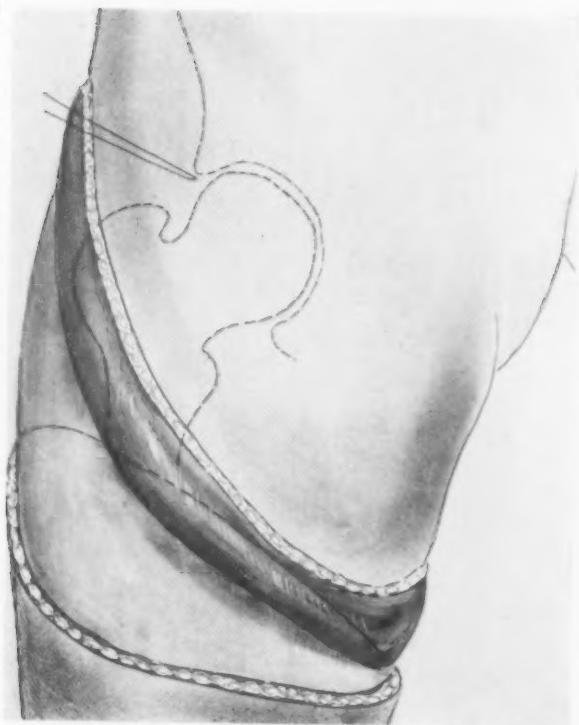


FIG. 7.—Knife entering capsule at coryloid margin, from which point it follows tone surface to meet circular incision, from which point it follows tone



Pic. 8.—Knife has severed round ligament and remains behind delivered head of femur to divide capsular ligament and attached muscles of lesser trochanter and shaft.

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of pulsating tumors which prove to be malignant growths. (4) For the prevention of hemorrhage in the removal of marrow growths. And concludes even at that early date and in the face of an astounding mortality that "A proper appreciation of the circumstances under which the primitive iliac artery has been tied for the arrest of hemorrhage will need the discriminating surgeon, notwithstanding the excessive mortality that has



FIG. 1.—Showing collateral circulation.

thus far attended its performance, to accord to this operation an important place among the resources of his art." After many years of effort on the part of various surgeons to control bleeding about the hip girdle by the aid of pressure upon the intra-abdominal vessels, McBurney, assured of the safety of invasion of the peritoneal cavity, practiced direct pressure upon the common iliac through the incision that bears his name, in three cases of hip-joint disarticulation with complete success. Since

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this time his method has been successfully applied by others. If it be true as stated by Halstead that gangrene of the extremity does not follow occlusion of the common iliac even without amputation, there can be no well-founded objection to permanent ligation of the vessel in preference to temporary compression, wherein control of the blood-stream must necessarily be somewhat indefinite.

The case reported by Brooks which was operated by him in July, 1920, as well as the one reported herein by the writer, were both extremely unfavorable risks. Both had been subjected to operative trauma and regeneration of malignant activity and presented physical conditions that made the procedures unusually unpromising. In both cases a preliminary ligation was done and both have recovered from the operation. It is true the number of cases which have received this preliminary step is so few that one has not the right to draw conclusions. It is not with the intention of assuming that unusual significance should be attached to any individual case that the author urges the application of this preliminary step in selected cases, but for the reason that the principles involved therein are supported by the accumulating experience of all the cases recorded, tending to prove: (1) That ligation of the common iliac is perfectly safe from the standpoint of continued viability of the stump; and (2) that hemorrhage is absolutely under control, time is saved and shock is materially diminished.

The report of the author's case is briefly as follows:

Master J. Kendis, aged thirteen years, entered St. John's Hospital in August, 1920, with a history of indefinite pain and swelling in the right knee, following an attack of tonsillitis. Tonsillectomy was performed and symptoms in the right knee disappeared for a few days. Swelling with terrific pain soon returned. Laboratory test taken at that time reported a three plus Wassermann. Antiluetic treatment was carried out for several weeks, even though repeated reexaminations begun immediately after the positive report have all been negative. X-ray report at the time showed a large area of bone destruction in the epiphysis of the right femur at the knee, extending onto the diaphysis at its lower end and mainly confined to the mesial side. No definite proliferation could be made out. Cortex of bone intact. Contiguous surface of the tibia not involved. There was slight increase in the synovial fluid of the knee-joint. The röntgenologist reported it a tumor strongly suggestive of giant-cell sarcoma. On October 28, 1920, a specimen of tissue containing bone was removed from the leg by Dr. A. Horwitz, who referred the case, and a pathological report was returned as follows: "Round-cell sarcoma with perithelial arrangement."—Dr. E. L. Opie. November 2, 1920, Dr. W. Temple, of Kansas City, reported from the same section, "Endotheliomata tumor belonging to sarcoma group." Dr. Ralph Thompson, pathologist of St. Louis University, on November 29, 1920, reported

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the specimen as osteosarcoma. The reaction incident to removal of tissue by Doctor Horwitz was unusually severe. As indicated by the graphic chart, the pulse-rate varied from 140 to 160, with a rise of temperature, ranging from 102° to 104°, and unbearable pain in the joint area. Smears from the wound secretion contained mixed bacteria, staphylococci and streptococci. It was determined to reestablish, in so far as was possible, the resistance of the patient before subjecting him to disarticulation at the hip. The wound was accordingly Dakinized for several days, with slight improvement in temperature, but no decrease in pulse-rate; consequently it was determined to proceed with the operation in the hope that removal of the pathology would be sufficiently beneficial to overbalance the danger of the operation, especially in view of the fact that his general condition was not improving and that metastasis was probably active. With the encouraging example of the successful case reported by Brooks, it was determined to ligate the common iliac as a preliminary step. Under ether anæsthesia the operation was performed, with the following technic:

Patient is placed in Trendelenburg position immediately following preparation of field of both operations. Incision (for ligation of common iliac) commences one inch above the umbilicus and near the mesial margin of the rectus muscle, which when exposed is retracted outward. A broad peritoneal exposure is thus obtained. Upon admitting air to the peritoneal cavity, the intestines fall back and but a light, moist, gauze compress is needed to maintain excellent exposure of the aortic bifurcation and both common iliacs. The peritoneum over the site selected is elevated, snipped and stretched, the artery by blunt dissection is isolated from the vein and elevated, the loaded ligature carrier directed toward the patient's left is passed under the artery, and the iliac doubly tied and interlocked by heavy braided silk. One hour-glass suture suffices to repair the peritoneal rent. The table is brought to a level and the abdomen closed in the usual manner. The entire procedure can be accomplished in a few minutes. Elevation of the affected limb is meanwhile maintained. For the completion of this report the exarticulation is briefly described: A circular incision at the selected height is made about the limb through skin and fascia, observing a line parallel to the line from pubic spine to iliac crest, that the anal side of the flap may be longer than the lateral. Selecting a point midway between the head of the greater trochanter and the crest of the ilium, a three-inch knife is thrust home to the head of the femur, entering the capsular ligament at the cotyloid margin. Continuing the pressure, the knife is carried down through all tissues to the femur on its lateral surface to join the circular incision below. The limb is elevated, the skin cuffed and the sciatic nerve exposed in its intermuscular bed at a height several inches above the proposed line of muscle section. The nerve is blocked with 1 per cent. novocaine, and 2 c.c. of alcohol, as suggested by Dean Lewis, is injected immediately distal to the novocaine infiltration and the

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nerve divided. Acutely adducting the limb, the round ligament is severed and as the head emerges from the longitudinal incision in the capsular ligament the knife remains behind and divides in one stroke the remaining joint ligaments. The muscle groups attached to the greater and lesser trochanters and the shaft may now be divided by a few strokes of the knife, the circular muscular incision at the base of the skin cuff completed and the limb removed. The femoral vessels are compressed by the free hand of the operator during this last circular stroke and immediately occluded with haemostats, as are the gluteal, sciatic, obturator, internal and external circumflex and two or three less significant branches, requiring in all not over eight ligatures to block the termini of the collateral arch. Because of the interest attached to the rapidity with which the collateral circulation asserts itself following deligation of the common iliac, the femoral was momentarily relieved after incising it and a fairly full stream of blood about the strength of the venous current greeted us. The bleeding from the less important vessels, such as the gluteal, sciatic and obturator was of less force, rising to a height of one to two inches, as they were relieved from the compress, for location and ligature. It is interesting to note that no pulsation was observed in any of the vessels that were permitted to bleed momentarily and that the stump, after the few ligatures were applied, remained perfectly dry. Mattressing the stump end was done for cosmetic effect and not for the insecure purpose of controlling oozing. A Dakin tube was directed into the acetabulum and one at the stump end, thus excluding infection and temporarily caring for dead space and serum accumulation. The after-care of the case presents no feature of interest, not depicted on the graphic chart. A donor was present, and kept available for use should occasion arise. Post-operative shock was never sufficiently alarming that hypodermic or intravenous medication was deemed necessary. The pulse-rate continued high as before operation, and while gradually slowing, remained above 100, and following each X-ray therapy was markedly exacerbated for a time.

As previously stated, conclusions based upon the slender support of a few successful cases would be valueless. Modern surgery has happily reached the stage when conservation is the aim and amputation the exception. Year by year the need for disarticulation at the hip-joint will diminish, but when demanded, will assuredly be less hazardous. The patriarchs of medicine who have had to blaze the trail, upon which we walk with comparative comfort and assurance, are deserving of unstinted praise. We are inclined to forget in our selfish enthusiasm the great work that our predecessors have accomplished, that has made our small contributions possible and upon which they are founded. The creation of such an impression is far from the desire of the writer. Attention is directed, in conclusion, but to a few points of interest in this report: Exarticulation at the hip-joint is a hazardous procedure, because of two factors. First:

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the injury or disease making the step necessary has already seriously handicapped the patient. Secondly, hemorrhage, shock, and sepsis in the presence of lowered vitality invite disaster. The logical solution, therefore, is: (a) To refrain, unless forced by emergency, from further trauma until recuperation compatible with safety is complete; (b) replenish by blood transfusion the depleted circulation, and reestablish as far as possible the physiological activity of the sufferer; (c) in elective cases control hemorrhage and therefore save time and shock by the five-minute procedure of preliminary ligation of the common iliac, and finally treat operative shock before it develops by preventing all blood loss, nerve and tissue trauma, and prolonged anaesthesia. It is in the belief that the steps suggested herein are directed toward safety, and are unfriendly to high mortality, that the case is reported.

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CANCER INFECTION*

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AS FAR back as medical history extends there have been certain diseases which have been looked upon and feared by the public because they have been supposed to be transmissible from one person to others in some way. Their mode of transmission has been explained in many cases since their etiology has been determined by finding certain micro-organisms which could be isolated, grown upon culture media, and which when inoculated upon healthy animals or upon human beings produced the identical disease from which the patient suffered from whom the original microorganisms were taken. In this manner diseases which had for centuries been looked upon as contagious or infectious were definitely proved to be so. Other diseases, like measles, scarlatina, and smallpox, in which it has not been possible to isolate the specific micro-organisms, are so evidently due to infection that no one is in doubt about this fact.

For many years the public consciousness—often called superstition—has recognized the infectiousness of tuberculosis, leprosy and cancer, while many of the most learned members of the medical profession have claimed the contrary because the infectious character has not been demonstrated on account of technical difficulties. These have fortunately been cleared away in the case of tuberculosis and leprosy, but not as yet, so far as general knowledge is concerned, in the case of cancer.

Had Robert Koch or some other investigator not demonstrated the tubercle bacillus, there is no doubt but what hundreds of thousands of healthy persons who are now protected against tuberculous infection would still be exposed to this danger precisely as they are exposed to the danger of infection from cancer to-day. This is due to a simple error in logic. We disregard the popular prejudice because we cannot demonstrate a scientific basis for this prejudice instead of accepting the popular prejudice as being in all probability based upon observation and knowledge which were lost during the dark ages, but which were well founded upon fact during the ages which preceded this period of ignorance. We say because we cannot find the agent of infection therefor it does not exist, instead of saying our ignorance and incompetence and lack of skill and insight have prevented us up to the present time from discovering this agent, hence we must approach the question always from a new

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angle until we will ultimately succeed in establishing conditions which will enable us to determine this cause.

We may say that the appearance of cancer is preceded so constantly by long-continued local irritation, as in smoker's cancer, the cancer of betel-nut chewers, that of paraffin workers, chimney-sweeps, etc., that we are justified in considering this irritation as the actual cause. What would we think of a farmer who would fail to put seed on his land because he has observed that the soil has to have a certain degree of preparation before a certain crop can grow? In the same way we have observed that cancer will develop very constantly on the proximal side of the pylorus and on the distal side of the ileocecal valve, while it will develop only rarely between these two points. The fields in which it will develop contain substances acid in reaction, while the intestinal contents in the intervening portion are alkaline. The farmer knows that he can grow rye in an acid soil but in order to produce a growth of alfalfa or red clover the soil must be alkaline. In either case, however, he must sow the specific seed which will produce the growth desired.

We know that it is an easy matter to transplant carcinoma nodules from one animal to another but that if these nodules are exposed to a temperature of 160° F. no growth will occur. This may mean that the tissue itself cannot live in a temperature higher than this or it may mean that this is the limit for the life of the infectious material causing the cancer.

For many years the fact that the few experiments in transplanting human cancer from one person to another have failed has been looked upon as proof for the non-transmissibility of cancer from person to person. Of course, this has been long disproved by animal experimentation, but it serves as an example of the harm that can be done by concluding that because one has failed to prove a fact therefore it has been disproved or because one has not been able to do it therefore it cannot be done. For years the failure of attempts to transplant cancer or to inoculate cancer from one person to another was used as an argument against the infectiousness of cancer. This would not be of much importance were it not for the fact that in the meantime, while we are waiting for some person who is competent to discover the cause of infection, the public are encouraged in exposing themselves to this infection, against which popular prejudice might otherwise protect these persons.

A study of the literature shows that less than thirty years ago Langstaff ("Studies in Statistics," London, 1891) and many others proved statistically and to their minds scientifically that tuberculosis is not infectious or contagious because in many families the husband or wife suffered and in many instances died from the disease, the other partner remaining free from it. This identical argument is being advanced in the case of cancer. The fact that the soil must be proper as well as the seed

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in order to secure growth is being overlooked in the case of the cancer as it has in every disease which has been classed as infectious or contagious by popular belief or prejudice.

The experiment of Miss Slye with white mice shows conclusively that certain animals are more susceptible to the development of cancer of heredity than others.

TABLE I

<i>India</i> Per cent. of Carcinoma deaths	<i>Japan</i> Rate per 100,000 population
0.0 Stomach	52.3
0.0 Esophagus	12.4
— 6.0 Liver	7.3
— 8.0 Buccal	2.3
— 1.4 Larynx	2.3
— 13.2 Skin	0.8
— 13.0 Breast	0.6
— 6.0 Uterus	11.0
— 18.0 Male genitalia	0.?

TABLE I.—Shows the difference in distribution of cancer to different parts of the body in nationalities whose habits of living are very different, the parts of the body exposed to contact with filth being extensively infected with cancer.

TABLE II
Total Cancer Mortality per 100,000

Copenhagen	161.3
Berlin	133.5
Amsterdam	116.7
London	111.7
Rome	100.5
Moscow	94.8
Sydney	90.1
Petrograd	85.6
Buenos Ayres	85.1
Chicago	78.9
New York	77.1
Tokio	73.6
Osaka	55.9
Calcutta	11.7

TABLE II.—Shows the number of deaths from cancer per 100,000 of population in different important cities.

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TABLE III
Hawaii, 1911-1913. Rate per 100,000 by race and organ.

	Total	Breast	Face	Int.	Stomach	Uterus
Japanese	19.8	0.0	0.0	12.1	57.6	18.2
Chinese	26.5	0.0	8.3	0.0	50.0	16.7
Portuguese	58.0	3.7	0.0	0.0	40.8	7.4
Hawaiian	93.8	13.7	0.0	2.0	27.5	29.4

<i>Asia</i>						
Ceylon	5.6	—	—	—	—	—
Hongkong	8.1	—	—	—	—	—
India	11.7	—	—	—	—	—
Penang	10.3	—	—	—	—	—
Japan	60.2	—	—	—	—	—
Shanghai	55.3	—	—	—	—	—

TABLE III.—Shows death rate per 100,000 by race and organ.

TABLE IV

	Stomach and Liver	Int.-Rectum Peritoneum	Breast	Skin	Buccal cavity
Switzerland	—	—	—	—	—
Holland	—	—	—	—	—
Japan	—	—	—	—	—
Scotland	—	—	—	not given	—
Uruguay	—	—	—	—	—
England and Wales	—	—	—	—	—
U. S. A.	—	—	—	—	—
Australia	—	—	—	—	—

TABLE IV.—Shows the relative frequency of cancer in different organs for various countries.

These tables were constructed from statistics taken from the volume published by Frederick L. Hoffman, statistician of the Prudential Life Insurance Company, who has given the subject an enormous amount of attention.

The fact that whole families of human beings have died of cancer has been used as an argument in favor of infection because living together they are all likely to be exposed to the same sources of infection. The same has been claimed for houses in which successive families have died of cancer.

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On the other hand, these conditions have been ascribed to coincidence or to hereditary tendency.

The fact that surgeons do not generally die of cancer has been given as an argument against infection. If one observes the care with which surgeons guard against possible infection of any kind this argument at once loses all weight.

The fact that we find the same histologic structure of metastatic cancer that we find in the primary growth has been used to discredit the infectious theory. Metastases must consequently be transplanted particles of tumor tissue and not infections at a distance from the original growth. If the cause of cancer is an infection apparently it sets free living cells, some of which will continue to grow after being carried to a distance by the lymph-stream or the blood-stream.

There seems to be an exception in case of Paget's disease of the breast, in which one may find squamous epithelium in the original cancer about the nipple, columnar epithelium in the secondary cancer along the milk duct and glandular cancer in the mammary gland, while there may be metastases in the axillary lymph-nodes with characteristic glandular cancer. In these cases apparently the skin, the milk ducts, and the gland tissues were successively infected, while the new growth in the lymph-nodes represents a true metastasis.

In urging the importance of taking every precaution against cancer infection, notwithstanding the fact that its infectiousness has not been proved, we simply suggest a wise precaution which can do no harm, while it may do an endless amount of good, because in case the disease is due to infection every additional case is a menace to others.

In the meantime it would be equally unwise to ignore the various other theories which have been advanced. According to Virchow's theory, cancer is due to local irritation either mechanical, as in the form of friction or pressure, as in smoker's cancer and the cancer of betel-nut chewers, or chemical, as in paraffin workers, chimney-sweeps, and electric irritation, as in X-ray workers, or heat, as in workers in certain trades.

This theory has an important practical bearing because by avoiding all of these forms of irritation undoubtedly many cases of cancer can be avoided, according to the view of those believing in cancer infection because the soil has not been prepared for the infection.

Colnheim's theory of embryonic origin, Hanseman's of "anaplasia," Ribbert's of "tissue tension," and Adami's of "habit growth," all aid in explaining the development of cancer, but in each instance the seed in the form of some form of infection is missing.

The fact that cancer is a disease of old age can be reasonably explained from the fact of: (1) Reduced resistance; (2) long years of exposure to irritation; (3) long time of exposure to cancer infection.

The fact that cancer occurs upon the exposed portions of the body and not upon the parts covered with clothing would point toward the

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fact that the exposed portions are not only more exposed to external irritation but also to infection.

In the case of the Kangri burns of Kashmir which cause cancer of the abdominal skin underneath the charcoal warmers worn over the abdomen, we have the constant irritation coupled with the fact that these people are extremely uncleanly, so that no part of their bodies is free from infectious material.

Cancer occurs almost exclusively in portions of the body exposed to the irritation of the outside world. This includes the gastro-intestinal canal which comes in contact constantly with filthy food in locations in which stasis insures long-continued contact and persistent irritation.

We find a notable example in the enormous amount of cancer of the stomach in manure-eating people, *i.e.*, people eating raw vegetables growing in soil fertilized with night-soil or with barnyard manure. A marked example of this is found in the Japanese, who eat such vegetables in abundance and who suffer greatly from cancer of the stomach, while the inhabitants of India, whose religion commands them to boil food and drink, are notably free from stomach cancer.

On the other hand, the Japanese are scrupulously clean regarding their skin, being habitual bathers in hot water. They are very free from external cancer. The people of India, on the other hand, who are not clean as regards their skin, suffer largely from cancer of the skin. The same is borne out among the manure-eating animals. Barnyard fowl are notoriously unclean in their diet and those individuals who do not lose their lives while young are very prone to suffer from cancer. The same is true of the pig, although according to our modern methods, these animals are marketed so young that they rarely reach the cancer age. Is it not possible that the founders of the Jewish law prohibiting the eating of pork may have been founded on knowledge? The same is true of dogs, rats, and mice, who are all subject to cancer, while animals like rabbits and others eating clean food are practically free from cancer.

Marine and Gaylord have shown that fish living in ponds infected with excrement develop cancer, especially of the gills, which are the least protected part of the body constantly in contact with the soiled water, while control animals living in pure water will remain free from this disease.

There are many facts which seem to point to sewage and manure as the home of the organism causing cancer. Behla made a careful study of Luckau and found that cancer was four times as common in the low-lying portions as in the higher regions; in other words, in the portions to which the drainage was carried. He also found much cancer in dogs in this region. He also found that the communities afflicted severely with cancer consumed large quantities of home-grown vegetables. In this part of the country human excrement is used extensively for fertilizing vegetable gardens. Haviland also found after careful analysis that low-lying districts are full of cancer. Mason, in his careful investigation of 400 cases at Leamington, England, came to the conclusion that sewage is

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an important factor in the production of cancer. An apparent discrepancy comes from the statistics of the city of Edinborough, showing that cancer was found to be more frequent in houses demanding a high rental while tuberculosis was more frequent in houses of low rents. However, it seems clear that the former occupants could afford to eat raw vegetables while the latter had to be satisfied with porridge and less expensive foods.

Again Meldorf states that of 1500 patients in Esquimeaux only 1 per cent. had tumors and that only a few of these were malignant. The low percentage of cancer in the arctic regions has been confirmed by many other observers. In these regions no vegetables are grown which are fertilized with human excrement or with manure, hence there can be no contamination with human excrement. An important exception to this is the city of Hammerfest, but I have not the data concerning its food supply nor its water and sewage systems.

In the tropics observers agree that cancer of the stomach is extremely rare. Here again this form of contamination is absent except where the vegetable gardens are conducted by the Chinese or Japanese. In the tropics human excrement is not used in fertilizing garden vegetables because these grow vigorously without this aid; moreover, fruits are so plentiful that they are used in preference and, of course, these are not easily contaminated.

In studying the statistics I have been impressed with the fact that cancer of the alimentary canal is uncommon wherever food and drinking water are not contaminated with sewage or manure. An interesting observation has been made in the case of the Chinese who drink no unboiled contaminated water but eat an abundance of vegetables fertilized with human excrement. As might be expected, they show a high mortality from stomach cancer.

The most convincing argument, however, of the infectiousness of cancer lies in the studies of Professor Smith, who has proved to the satisfaction of those competent to judge that cancer in plants is due to a microorganism which he has been able to isolate and cultivate and which produces cancer when inoculated upon healthy plants. In human cancer further studies are needed, and it is hoped that these will be continued vigorously and that in the meantime healthy persons be not exposed unnecessarily to cancer infection.

The fact that none of the many observers like Roppin, Schill, Francke, Lampiasi, Scheuerlen, Konbassoff, Doyen, Wickham, Thoma, Sjoberg and many others have been able to prove to the satisfaction of others that they had found the microorganism causing cancer must not be construed to prove that such an organism does not exist, because precisely the same failures were experienced before the tubercle bacillus, the bacillus of leprosy, the spirochete of syphilis, the plasmodium of malaria, and many others were finally discovered.

Clinically all of these diseases were infectious and it was only a matter of patient labor to find the living cause.

CARCINOMA OF THE KIDNEY*

BY JAMES TAFT PILCHER, M.D.

OF BROOKLYN, N. Y.

PRIOR to 1883 no attempts to classify renal tumors appear to have been undertaken, practically all being described either as lipomata, cancerous or cystic. Grawitz, however, at that time definitely identified a certain predominating group as originating from adrenal rests. These are now known as hypernephromata. His observations were contended chiefly by Stoerk and Sudeck, who claimed that they were of renal origin, while Wilson in a recent exhaustive embryological study believes that these tumors arise from islands of nephrogenic tissue and suggests the term of mesothelioma to designate them.

Etiology.—In 1884 Labourin, in examining tumors of adenomatous character, stated that he believed they arose as a process of epithelial transition in certain instances of chronic nephritis. The observations of Taddei and Kitchenski tend to a more plausible explanation, which may be supported by many analogous facts found elsewhere in the body; namely, that carcinoma of the pelvis of the kidneys is quite probably due to a metaplasia of its transitional epithelium, and that it is the stimulation of these plaques of leucoplakia either by a preexisting stone, infection, or by chemical reaction of retained secretion that causes the resultant growth. The observations of Israel, Kielleuthner, Oraison, Rokitansky, Weichselbaum, Kauffmann, Halle, Orth, Bauer, Albarran and many others would lend credence to this theory.

The relationship of the presence of stone to cancer of the kidney is interesting in that statistically the percentage of their occurrence coincides very closely with the formation of cancer in other parts of the body where definite irritation is demonstrable, thus, as pointed out by Coryell in a study of fourteen cases of cancer of the kidney operated at the Mayo Clinic, nine, or 64 per cent., were associated with stones and five, or 35 per cent., occurred without stones, thus allowing an interesting analogy to be drawn between the relative frequency of gastric cancer developing on a gastric ulcer, and that of cancer of the kidney and the concomitant finding of stones.

In Coryell's study of local pathologic processes found in these stone cases, substantiation of the probability of the existence of a pre-cancerous stage is noted in the fact that one of the primary results of the presence of calculi is the proliferation of fibroblasts beneath the tubular epithelium. He believes that this newly formed tissue disturbs the normal equilibrium existing between the epithelium and the connective tissue,

* Read before the Society of Alumni of Bellevue Hospital, January 5, 1921.

which results in an epithelial proliferation. Thus it would appear evident that over-production of epithelial tissue in these conditions is due to a chronic irritation, and that the connective tissue becomes less resistant against the epithelial cells, as stated by Thiersch, while Ewing carries the process still further in stating that although the "epithelial growth follows the analogy of normal gland formation, owing to the process of adaptation to abnormal environment and loss of function, the atypical structure of cancer results." This attempt of cells in cancer of the kidney to mimic the formation of renal tubules has also been noted in the personal cases observed. It is most difficult to appreciate just where the inflammatory hyperplasia stops and the cancerous cells begin, and, as Ewing states, there appears to be an insensible gradation from one to the other. The process is stated schematically by Coryell as (1) normal; (2) inflammatory; (3) hyperplastic; (4) neoplastic (either benign or malignant).

There appears in all cases examined some type of inflammatory reaction. This may be due either to stone or infection, and in a very great majority of cases one notes that there has been either an intermittent or a continuous obstruction at the ureteral introitus. It is usually for this that the patient seeks advice. Ochsner feels that this stasis is the real factor stimulating the previously irritated tissues to cancer formation due to the continued presence of the acid medium.

Two types of carcinoma are to be noted, an infiltrating growth usually springing from the renal pelvis, and an adenomatous type invariably originating from the renal tubules. The papillomata found occasionally in the pelvis take on the characteristics of those seen in the bladder and while possibly benign in the beginning, unquestionably become the malignant papillary carcinoma when seen in the later stages, as so frequently occurs in similar vesical growths.

The average occurrence of carcinoma of the kidney when taken in relation to other tumors of this organ is about 7 per cent. The majority occurred before the age of fifty, while hypernephroma is more frequent after fifty. Males appear to be more susceptible to the development of carcinoma of the kidney, the ratio being about six males to four females. It occurs equally on both sides, and malformation or malposition does not appear to influence its occurrence, although it has been found in two instances of horseshoe kidney (Wolff, Primrose) as well as in an ectopic organ (Young), and although due to the rarity of these conditions these instances are striking, one can hardly ascribe much etiologic significance to the coincidence. The relationship of trauma apparently need not be considered nor does heredity influence the occurrence of kidney growths any differently from cancer found in other parts of the body.

Diagnosis.—There is no symptom-complex or pathognomonic sign whereby one may differentiate between the different pathologic processes present in solid tumors of the kidney, nor would anything be gained in so doing other than academic interest. The treatment is the same for

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all—radical surgery. However, it is of the utmost importance that these conditions be recognized at the earliest possible moment, and according to the situation of the tumor this may be relatively simple or extremely difficult, taxing the ingenuity of the diagnostician to its utmost.

Three primary facts are to be considered, as it is invariably one or more combinations of these that first impels the patient to seek the physician. In their relative frequency of occurrence they are: (1) haematuria; (2) pain; and (3) tumor.

Hæmaturia.—Hæmaturia occurs in approximately 60 per cent. of cases of tumor of the kidney and holds good both for carcinoma and for hypernephroma. It may occur as a symptomless hæmaturia and exist either continuously or, what is more commonly the case, intermittently for months or even years. In Braasch's series of eighty-three cases it existed for more than one year in 77 per cent. Hæmaturia does not necessarily indicate involvement of the pelvis, although this is usually the case, but may come from the parenchyma, in some instances at least, due to congestion. The character of the hemorrhage is in many cases quite profuse but transient and not of much severity in the earlier stages. Its presence is of the greatest aid, however, when occurring at the time of examination, as its origin can then be definitely localized. The presence of microscopic blood is of questionable value, as the errors in technic in obtaining it through ureteral catheters are so many and so easily and unintentionally committed, and other more definite findings so simply obtainable that but very little weight should be attached to this finding other than corroborative, and when found in passed urine it has no value whatever; indeed, in fifty cases of abdominal tumor simulating renal tumor examined by Braasch, but which on operation were found not to involve the kidney, 6 or 12 per cent. showed microscopic blood in the urine.

The appearance of frank blood in the urine in the large majority of cases of cancer of the kidney is usually symptomless, occurring without pain unless there is distal obstruction, when more or less ureteral colic is stimulated as the clot is passed.

It is a fallacy to believe, as is frequently stated, that pyuria is seldom present in renal growths, as in records of 126 cases pus was found in 39 per cent. of them, and we believe even this number smaller than it should be, as inflammatory infiltration is present in practically all of the stone cases at least.

Fibrinuria is an extremely rare condition which has been noted in two cases of tumor of the kidney—one a sarcoma, the other a carcinoma. As there are but twenty-six cases of this urinary phenomenon on record, it might be of interest to keep it in mind.

The writer saw last fall a most extraordinary instance of fibrinuria in an elderly woman, whose blood-pressure frequently ranged

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between 270 and 300. She was extremely stout, so that abdominal palpation was impossible. The cystoscopic examination was negative, as was also radiographic examination of her kidneys. She would unfortunately not subject herself to pyelography and died after a few months apparently from nephritis and myocarditis. She not only voided, without discomfort, great masses of pinkish-white, transparent, gelatinous material, but at intervals the urine would be voided clear and the presence of fibrinogen convincingly demonstrated by the subsequently forming coagulum.

Pain.—The character of the pain complained of is not at all diagnostic of tumor of the kidney, as it varies not only in character, but also in its intensity and duration, in each instance being dependent upon its etiologic factor. Thus, one may have the colic of engagement of a stone or that accompanying the passage of a blood-clot; again the distention of the tumor causing pressure and local congestion gives the dull ache frequently complained of. Similar sensations occur from the frequency of concomitant hydro- or pyonephrosis. Peripheral pressure may cause neuralgic radiations to most any part of the abdomen; lumbago or muscular rheumatism are terms most commonly used to describe it. That it is an important element to consider in early diagnosis is evidenced by the frequency of it being the initial symptom complained of. Braasch states that he found it the primary complaint in 32 per cent. and present at some time during the course of the disease in 82 per cent. of the eighty-three cases considered. Acute, sudden or bursting pain may be interpreted as being due to a hemorrhage into the tumor or under its capsule or into the occluded pelvis, particularly if there is a sudden increase in the size of the tumor.

Tumor.—The presence of a mass as the first evidence of a renal growth, taking the collected statistics of Albarrn, Imbert and Braasch as a criterion (386 cases), shows it to have been noted in about 19 per cent., while after examination 82.4 per cent. of tumors have been identified in a series of 562 cases (including those of Garceau). Its shape and degree of fixation are extremely variable, both dependent on the nature, situation and character of the growth, and on the degree which metastases have fixed it to adjacent structures.

In the majority of the cases personally examined, it had tended to conform to the shape of the kidney itself and is difficult at times to differentiate from it, as a large white kidney simulates very closely the earlier stages of tumor formation before the process has invaded the subcapsular tissues. They are frequently irregular and bosses may at times be readily appreciable. In general it may be stated that owing to frequently abnormally placed kidneys and to the presence of adjacent organs, the seat also of growths, it is quite inadvisable to base a diagnosis of renal tumor on palpation alone unsupported by other and even more indicative findings.

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Diagnosis.—Probably the one single demonstrable fact that we have at our disposal upon which one may base the most accurate diagnosis of renal tumor, is the pyelogram. Frequent instances have been encountered, however, where this has been impossible owing to the impermeability of the ureter, either from stricture or from involvement of the tumor growth itself. The technic of its accomplishment is rendered safe and symptomless by allowing a 25 per cent. solution of sodium bromide to distend the pelvis of the kidney by gravity—the deformity noted may be of varying type, the most usual is the so-called "spider leg" appearance due to the retraction of the calyces into the cortex. The second most frequently found deformity is the splitting up of the pelvic shadow into irregular and disconnected streaks, probably due to incomplete occlusion of the normal cavity by invasion of it by the irregular tumor masses; much may also be inferred from lateral or mesial deviation or displacement of the shadow of the pelvis from pressure upon it or dislocation of it by the tumor. The ureter may itself show deformity in 70 or 80 per cent. of the cases owing to either tumor infiltration or external pressure upon it by a surrounding growth. One must be careful not to be misled by the finding of a stone shadow to believe that this is the only pathologic process present. Valuable data may further be obtained by general radiography of the kidneys, particularly by employing the pneumoperitoneum technic of Fischer, as not infrequently we may obtain shadows of the tumor mass, especially if a hemorrhage has occurred into it, or in thin people with dense tumor structure.

Renal functional tests are of doubtful value and should be interpreted with caution—no dysfunction is apparent in the large majority of cases unless there is a marked inflammatory reaction, when it is quite definitely decreased. We employ the phenolsulphonephthalein test exclusively, as not only retardation of elimination time but also quantitative estimations may be observed.

Accessory aids in the diagnosis may be found in various circulatory phenomena. Thus Guyon, in 1881, called attention to the presence of varicocele. This is particularly suspicious when occurring suddenly late in life or with the onset of kidney symptoms; it is coincident in between 25 to 30 per cent. of the males examined. Braasch observed the recent appearance of hemorrhoids in 16 per cent. of the last thirty cases examined.

Cystoscopy frequently demonstrates dilatation of the trigonal and adjacent veins or an atresia of the ureteral opening on the affected side, while blood-clots or discolored urine may be seen issuing from the ureter, or changed characteristics of the ejected urine, either in force or frequency, are occasionally noted.

The prognosis is very serious even in the most favorable cases, not only because of the usually advanced condition of the growth before it comes to operation, but there is a tremendous operative mortality—between 30 and 50 per cent. Owing to the lack of facility with which these large

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tumors can be dealt with, through approach by the usual lumbar route, we do not hesitate to extend the incision transversely as far as the rectus muscle if necessary, and even further enlarge the approach by extension upward or downward. When one is able to infer that a papillomatous growth of the pelvis of the kidney is the probable lesion, because of concomitant finding of vesical papillomata, a complete ureterectomy should also be done either at the primary operation or secondarily, as recurrence in the ureter has been noted in six instances. The immediate shock from separating densely adherent tumors from surrounding structures and the resultant hemorrhage are factors which one has to contend with in many cases. A section of the inferior vena cava has even been removed accidentally; the operator was, however, successful in repairing it. The duodenum may readily be injured. Firm adhesions to the diaphragm may cause much inconvenience.

The subsequent history shows a very large percentage of recurrences—the approximate numbers of probable "cures" from considering many statistics is in the neighborhood of 25 per cent.

I append six histories of cases which have been shown pathologically to be carcinoma of the kidney. My thanks are due to Doctors Sherwood and Westbrook for permission to report their cases.

CASE I, Pilcher Clinic, No. 2962.—H. M. V., male, aged fifty-two years. Referred by Dr. S. S. Brown. Symptoms nine years ago after a severe attack of pain in left kidney region; reports having passed a small stone. Two years ago had three similar severe attacks accompanied by a temperature of 102°. During all this period has had intermittent aching pain in left kidney region. Developed a right hydrocele in 1915. Urine examination at various times has shown many hyalin and granular casts. At no time has he passed blood. Examination shows presence of an irregular, firm mass in upper left quadrant of abdomen, moderately tender, somewhat movable. Cystoscopic examination: Atresia left ureter, opening barely admitting a No. 3 bougie to the brim of the true pelvis, 26 cm. No urine was seen to escape from left ureter, normal flow from right. P. S. T., 60 per cent. (all from right kidney). Radiographic examination demonstrated the outlines of the tumor very distinctly. Pyelography was impossible owing to occlusion of left ureter. Operation, October 30, 1919. Longitudinal incision along left semilunar line with transverse extension into lumbar region. Two-thirds of the large mass was held firmly above the level of the costal border by adhesions to the diaphragm. At an advanced stage of the enucleation, the mass ruptured, inundating the field with old and fresh blood-clot and detritus. Imminent dissolution of the patient was met by immediate intravenous infusion into jugular vein and transfusion of 600 c.c. citrated blood, Group No. 4; reaction satisfactory. Clamp left applied to pedicle. Convalescence was delayed by the formation of a jejunal fistula, which eventually closed spontaneously.

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Pathologic Report: Gross appearance showed a large varicose mass, size of adult head, partly evacuated of organized blood-clot; attached to the lower and inner part of this mass could be distinguished kidney structure surrounded by a greatly thickened capsule. *Cut section:* Markings indistinct, parenchyma waxy and pale—moderately dry. Pelvis greatly dilated and filled with organized blood-clot—its walls were rigid and showed encroachment on its surface of a malignant extension, which entirely surrounded it and extended half way through the parenchyma proper. The upper pole of the kidney was the seat of an extensive malignant process which at one point had broken through the capsule, with a subsequent extracapsular hemorrhage forming the major part of the tumor mass. The ureter was occluded by organized blood-clot.

Microscopic examination shows the structure of the tumor mass to be that of a papillary adenocarcinoma. The cyst wall shows connective-tissue proliferation containing some atrophic renal tubules and enveloping a mass of adenocarcinomatous tissue. There is also a large amount of infiltration with small round-cells.

In this history will be noted the complex of stone, infection, nephritis, stasis and carcinoma extending over nine years. The patient is in perfect health at the date of this report, sixteen months after operation.

CASE II.—Major M. C., male, aged fifty-nine years. Service of Doctor Sherwood at U. S. A. General Hospital No. 1. Well until one month ago. Sudden onset, chills and fever; urine showed hyalin and granular casts and pus. Leucocytosis of 15,800; polymorphonuclears, 81 per cent. Cystoscopic examination demonstrated complete occlusion of right ureter. First operation by Doctor Sherwood July 17, 1918, large cystic tumor evacuated of more than a quart of thick, brownish pus. Second operation, August 26, 1918, by Doctor Sherwood, removal of kidney, examination of which showed it to be the seat of a new growth, involving the entire pelvis and first three inches of the ureter. Uneventful recovery. Patient in perfect health at present time, two years and three months after operation. Pathologic examination showed it to be a papillomatous carcinoma of the kidney. There were no stones found. ANNALS OF SURGERY, 1919, vol. lxx, page 624.

CASE III.—W. F., male, aged thirty-six years. Surg. Service B. Brooklyn Hospital (No. 1288). Operator Doctor Westbrook. Symptoms: Sharp pain in left side and haematuria one and one-half years before examination, six months later, similar pain but no blood. Present attack began four days before admission. Pain left lumbar region steadily increasing, radiating down ureter, accompanied by frequent micturition, no blood. Operation, medium lumbar curved incision, kidney adherent at upper pole, blunt separation and removal. Pathological report shows moderately enlarged kidney 12 by 7 by 6 cm. Presenting on section a round, definitely circumscribed tumor in upper half, 7 cm. in diameter. The cut surface bulges, has a pale, yellow color with hemorrhagic areas scattered over it. Consistency soft and boggy. The lower segment projects into dilated crescentic-shaped calyx, connected with pelvis by a narrow opening, no stone. *Microscopic*

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examination.—Papillary adenocarcinoma, probably originating in the renal parenchyma.

CASE IV.—M. C., male, aged forty-two years. Surg. Service B, Brooklyn Hospital (No. 1217). Operator Doctor Westbrook. Symptoms: Pain, severe, right loin five months ago. Lancinating, duration few minutes. Three days later noticed blood in urine. Attack of pain repeated three months ago, followed by passage of clot, but no calculus passed. Since has been passing blood intermittently without pain. Right kidney palpable, does not appear enlarged, not movable. Ureteral catheterization shows normal function left kidney and greatly diminished right kidney function. Operation: Angular lumbar incision. Kidney one-third larger than normal. Two nodules at upper pole and large projection into pelvis. Organ removed with difficulty, much hemorrhage. Pathological report shows growth to be of epithelial character. Diagnosis: Carcinoma right kidney. Subsequent history: Two and one-half months later a recurrent carcinomatous nodule was removed from the scar. There have been no other signs of recurrence to present (three years).

CASE V.—H. S., female, aged seventeen years. Surg. Service B, Brooklyn Hospital. Operator Doctor Westbrook. Symptoms: Two years before examination, had pain referred to epigastrium and a similar attack two months ago, with inability at each time to void. With subsidence of pain, a large quantity was passed strongly bloodtinged. The urine in the interim had been slightly bloody at intervals. For seven months had noticed a non-tender swelling in left side. Cystoscopy demonstrated the probable existence of an hydronephrosis, but not enough bromide solution was injected to detect the calyces. Operation, March 23, 1920. Nephrectomy, with rapid recurrence in two and one-half months. Microscopical diagnosis: Carcinoma of kidney.

CASE VI.—Seney Hospital (No. 942). Service of Dr. L. S. Pilcher. December 3, 1889. Mrs. S. D., aged fifty-three years. One and one-half years ago small lump first noted high in right iliac region. For six months dragging pain in right iliac region. General deterioration of health; nausea; occasional vomiting; loss of appetite and loss of strength and weight; flatulence. Urine, acid, 1013; albumen trace; sugar, 0; hyalin and granular casts, leucocytes. On admission to hospital there was a large, firm, slightly lobulated tumor occupying right half abdomen, slightly tender. Dulness continuous with liver. On exploratory incision the kidney, cæcum, and the mesocolon were found involved in a carcinomatous growth; no attempt at removal made; death fourteen weeks later. Autopsy: Whole kidney except upper pole involved.

CONCLUSIONS

1. Carcinoma of the kidney may develop from either the epithelium of the pelvis or from that of the renal tubules.
2. Its inception is apparently due to the presence of an irritating factor, as stone, infection, or stasis.

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3. There appears in all cases examined some area of inflammatory process.
4. The neoplastic tissue seems to develop not at the point of irritation, but peripheral to the round-cell inflammatory reaction, one process merging into the other.
5. Cystoscopy is absolutely essential in every case of hæmaturia to ascertain the source of bleeding. It is not a symptom which allows of procrastination in determining its etiology.
6. If from either or both kidneys, a pyelogram should be made if possible.
7. Exploratory operation should be performed if there is any question of the diagnosis.
8. Early recognition has been rare, and the prognosis is correspondingly grave.

CARCINOMA OF THE PELVIS OF THE KIDNEY

BY ALEXIUS McGLANNAN, M.D.
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TUMORS derived from the epithelium of the pelvis of the kidney are much more uncommon than growths having their origin in the more highly specialized epithelium of the parenchyma of this organ. Watson and Cunningham had only one tumor of the pelvis in a series of ninety-eight growths involving the kidney. At the 1913 meeting of the Southern Surgical Association L. B. Wilson reported four tumors of the collecting portion of the kidney among ninety-two renal tumors (*ANNALS OF SURGERY*, 1913, lvii, 522). McGown (*Jour. Amer. Med. Assoc.*, October 30, 1920, lxxv, 1191) reports forty-eight cases of papilloma of the pelvis of the kidney, which number includes a case of his own, two previously unreported cases of other observers, and the remainder found in an exhaustive study of the literature. In the discussion of McGown's paper eight more cases were reported, including that of Stevens (*Jour. Amer. Med. Assoc.*, June 5, 1920, lxxiv, 1576).

Practically all of the tumors of the renal pelvis have a papillary structure, and in their onset are benign. A few reported tumors seem to have originated in flat masses of squamous epithelium, probably in an area of leucoplakia. The papillary tumors, like those of the bladder, have a marked tendency to malignant change. Such malignant change is certain to follow an incomplete removal of one of these tumors. Although in some of the reported cases the tumor has been present several years and apparently has retained its benign qualities, all these tumors are potentially malignant, and should be treated with this fact in mind.

When the papilloma becomes malignant the architecture of the tumor is reproduced. As such a tumor becomes older, the papillary arrangement will be lost in the deep infiltrating areas, and here the epithelial cells become diffuse as medullary or scirrhus carcinoma. The infiltrating tumor almost invariably grows into the parenchyma of the kidney and the cortex may be perforated.

Secondary growths seem to be produced by implantation. In this way the occurrence of complicating tumors down the ureter and in the bladder may be explained. Metastases by way of the perirenal lymphatics involve the upper lumbar lymph-nodes about the aorta and vena cava. Late metastases occur in the liver and the lungs, but rarely in the bones.

No definite relation can be found between the development of the papillary tumors and the presence of stone in the kidney. That leuco-

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plakia may be the result of calculus irritation and in turn be the source of a squamous-cell tumor is a possibility. There is great difficulty in studying the reported cases, because in very few incidences has the type of the tumor been definitely described.

Nephrectomy is required for the removal of these tumors. The ureter should be carefully investigated and as much of this organ as is indicated should be removed because of the danger of an implanted growth in its lumen. In many cases complete nephro-ureterectomy should be done. Some authorities believe the latter should be the operation of choice in all cases.

The symptoms of papilloma of the renal pelvis are fairly typical. Hæmaturia is almost constant, and the quantity of blood lost may be sufficient to disable the patient. There is some blood in the urine almost all the time, and at intervals profuse hemorrhage occurs and may persist for days or weeks. The profuse bleeding is usually preceded by colicky pain and this intermittent hæmatonephrosis is considered a characteristic symptom (Israel, quoted by Ransohoff, "Keen's Surgery," vol iv, p. 247). The presence of transitional epithelium in the urine is a valuable corroborative symptom.

The kidney is seldom enlarged by the growth and therefore a palpable tumor is not present. An accompanying renal calculus may be shown by the X-ray. After collargol or similar injections which visualize the kidney pelvis and calyces, the X-ray shows alteration in the outline of the pelvis or some other deformity of this part of the kidney, varying in extent with the size of the tumor.

Cystoscopic examination will show the condition of the bladder, and the side from which the blood comes. Catheterization of the ureter permits segregation of urine for functional tests. The function of the involved kidney is usually impaired.

The differentiation from essential hæmaturia is not always easy. The bleeding from a tumor will not be controlled by the measures which are effective in essential hæmaturia, and in this lesion the deformity of the pelvis, as shown by X-ray, does not occur. Alteration in the function of the kidney, which is common with tumor, does not take place with the essential hæmaturia.

The case which I now report makes fifty-seven on record at this time, and is the eighteenth American case.

B. S. H. No. 228. The patient, a white man, aged sixty-seven years, was admitted to the Bon Secours Hospital, Baltimore, February 22, 1920. He was referred by Dr. W. A. Glines, of San Juan, Porto Rico.

The patient complained of persistent hæmaturia, weakness and shortness of breath. The hæmaturia had been almost constant for

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two and one-half years. There were occasional short periods when the urine seemed free from blood. After these periods he would have an attack of colicky pain in the region of the left loin, which would gradually subside as the bleeding returned. These attacks of intermittent haematuria took place about once in three months. At the onset he had frequency of urination with some obstructive symptoms. An enlarged prostate was removed two years ago. After this operation the bleeding subsided for about a month. Thrombo-plastin and other coagulants were given at intervals during the next two years, but without effect. In January, 1920, Doctor Glines found transitional epithelium in the urine.

Physical examination, made on admission to the hospital, was negative, except for great pallor, a loud murmur at the base of the heart, palpable radial arteries, and a little tenderness over the left kidney. The urine was a claret color, containing many red blood-cells, but no casts. The blood count showed 3,100,000 red cells with 50 per cent. haemoglobin, but no abnormal cells. Wassermann reaction negative.

Cystoscopic examination (February 25th) by Dr. A. G. Rytima proved the bladder normal, and showed the blood coming with each spurt of urine from the left ureter, while the right side sent out clear urine. The patient was quite worn out when the examination had reached this stage, and therefore the ureters were not catheterized. X-ray examination was negative for stone. Because of the large amount of blood in the urine, the phthalein test was unsatisfactory, but the blood urea was found to be .48 gram. per litre.

A diagnosis of papilloma of the pelvis of the left kidney was made on the following points. There was bleeding from the left ureter, with attacks of intermittent haematuria. Transitional epithelium had been found in the urine. The bladder was clear. X-ray did not show a stone. There was no palpable tumor. Hypernephroma or other tumor of the parenchyma, of two years' duration, should have made a large mass.

On February 29th, Dr. J. A. Ward gave the patient a transfusion of 500 c.c. of blood by the citrate method. On March 5th the red cells were 3,860,000 and the haemoglobin 60 per cent. A second citrate transfusion of 550 c.c. was given by Doctor Ward on March 6th, and the next day the red cells were 4,000,000 with 65 per cent. haemoglobin. A son of the patient was the donor on both occasions. Neither transfusion was followed by any disagreeable reaction.

Operation (March 9th).—McGlannan. Anaesthetic, ether; S. G. Davis. The left kidney and four inches of ureter were removed by lumbar nephrectomy. To avoid transplantation in the wound, the cavity was packed with alcohol sponges during the delivery of the kidney and before closing was flushed with alcohol. The wound was closed with a cigarette drain.

The post-operative course was uneventful and the patient was



FIG. 1.—The kidney opened out to show the cauliflower-like tumor filling the greater part of the pelvis and infiltrating the parenchyma (Photographs by Mr. H. Schapire).



FIG. 2.—Low power photomicrograph of the papillomatous area.

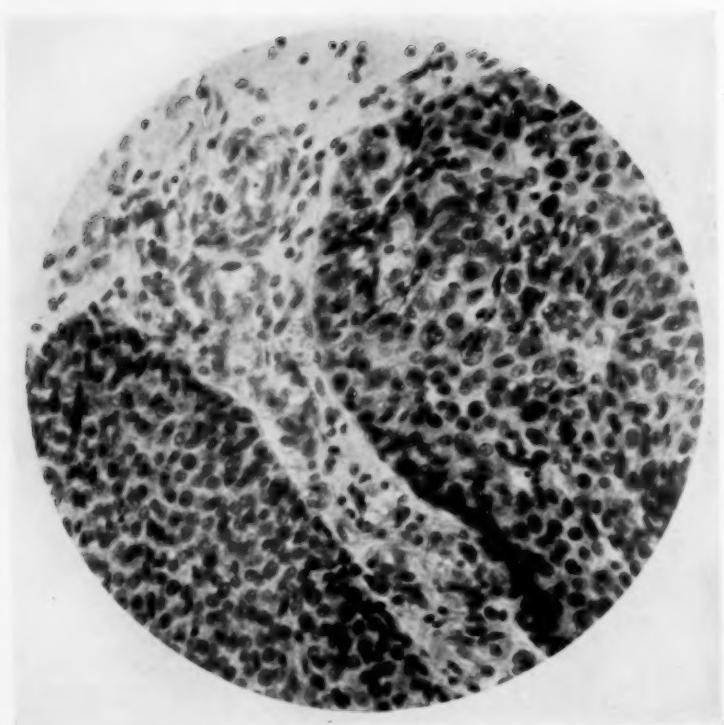


FIG. 3.—High power photomicrograph to show the type of cell.

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discharged April 2nd free from symptoms. He is now well nine months after operation.

Gross Pathology.—The kidney is small and the cortex narrow. The cauliflower-like growth occupies the entire lower half of the pelvis and branches out into the upper half. The base of the papilloma is hard, definitely malignant, and infiltrates the parenchyma of the kidney almost to the capsule. The tumor, however, is clearly confined to the kidney. The ureter is free from any growth or extension.

Microscopic Pathology.—The papillomatous structure of the tumor is preserved in the greater portion of the section, but several areas of epithelial cells are found in irregular nests without any definite arrangement, making their portion of the growth medullary carcinoma. There are no squamous cells nor areas of cornification. The tumor, therefore, is a malignant papilloma becoming medullary carcinoma.

END-RESULTS OF OPERATIONS FOR BONY ANKYLOSIS OF THE JAW*

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IN 1916 I reported to this Society three operations for complete bony ankylosis of the jaw. Since then I have operated upon three more, and the results have been so good, as well as the end-results in those reported four years ago, that I feel that I should put them on record. Particularly so, because the impression seems still to exist that these cases are hopeless. At least, five of my patients had been told by surgeons of considerable experience that nothing could be done.

The fact that the operation is one of the most satisfactory in surgery, should now be generally known, for the condition is not extremely rare and many patients are still going without relief because they have been told it was impossible.

The operation, while not really difficult, should not be lightly undertaken by those who have not had considerable experience with bone surgery and who have not made a careful study of the subject and of the individual upon whom he is to operate. For the mechanical difficulties are greater than would appear on the surface, and many surgeons, excellent in other lines of work, would find themselves puzzled or even non-plussed when operating for the first time on bony ankylosis of the jaw.

There are numerous important structures in close proximity to the field of operation, among which may be mentioned the parotid gland, Stenson's duct, the facial nerve, temporal internal maxillary and carotid arteries. The depth of the ramus of the jaw, its width, thickness and hardness, and the entire absence of any demarcation between the jaw and the base of the skull, as well as the obliteration of other landmarks, will be a surprise to anyone operating for the first time (see Fig. 1).

However, by using the instruments and method devised by Doctor Murphy, and a suitable drill for cutting the bone, the operation can be done with comparative ease and with safety. The Murphy operation and instruments have been well described by Kreuscher in the *Interstate Medical Journal* for October, 1916, and I shall not describe it here, but my further experience has taught me some accidents that are prone to occur and the way to avoid them, and I wish to put them on record for the benefit of others.

1. The temporal artery can be felt and located and the vertical incision made just anterior to it.
2. The horizontal arm of the incision may be made along the

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lower border of the zygoma instead of the upper border, as recommended by Murphy, and still be above and parallel to the main temporofacial branches of the seventh nerve, and may be carried down to the bone with one sweep of the knife. No important structure will be cut.

3. To get one's bearings, make a careful dissection at the anterior end of the horizontal limb of the incision, drawing down the wound until the anterior border of the ramus can be felt and freed sufficiently to get a Murphy retractor under it (see Fig. 2).

4. The parotid gland in all my cases projected over the ramus almost, or quite, to its midline, and can hardly be distinguished from the fat and connective tissue lying in that region. In my first



FIG. 1.—Shows the solid ankylosis and total lack of any line of demarcation between jaw and skull found in all my cases. Dotted lines show the bone to be cut away, leaving a rounded point for articulation.



FIG. 2.—Shows the bone exposed and isolated by the retractors.

four operations I injured or cut into it three times with a salivary fistula as the result. Although these fistulas all healed spontaneously in from three to eight weeks, they were very annoying for a time, and necessitated frequent redressings.

This accident may be almost certainly avoided if the operation is begun as recommended above and the subsequent dissection made by lifting up all tissue over the bone *en masse*—keeping close against the periosteum until the posterior border of the ramus is reached, the only incision *through* these tissues being a deepening of the original skin incision over the lower border of the zygoma and well above any important structure.

The second Murphy retractor may then be inserted under the posterior edge of the ramus until it meets the first one behind the centre of the bone.

5. The bone is then found to be completely isolated in the region to be divided by boring a chain of $\frac{5}{8}$ -inch holes through it with my cranial drill (see Fig. 3) and connecting them with a gouge chisel, cutting away the bone as shown in the dotted lines in the accompanying Fig. 1.

The bone should be gouged out without hammering, and this can be easily done if the holes are bored close together. This can be done more easily and more quickly than division with a Gigli or other saw, and allows a shaping of the bone as indicated by the dotted lines in Fig. 1. It also takes out a thicker section of bone than a simple saw cut, and I believe this is a good thing in preventing pressure on tissue interposed between the cut ends. I have always opposed the use of a chisel and mallet upon the skull, particularly the base of the skull, near the mastoid and maxillary articulation. We all know how easily one may be knocked out by a slight blow on the chin, and I have seen cases of severe and even fatal shock following a vigorous use of the mallet and chisel, that I believe were due to this cause.



FIG. 3.—Cranial drill.

By use of the Murphy incision and the careful dissection above recommended the facial nerve will not be injured and bleeding avoided as well as the danger of injury to the parotid or Stenson's duct.

In most cases where the affection is one sided, the mouth will open readily after division of the bone, even when the case is of long standing.

In some, however, particularly where both sides have been affected, the masseter, pterygoids, and other muscles have become so contracted that even with considerable force the teeth cannot be separated more than one-half or three-quarters of an inch. Great care should be observed in prying open the mouth in such cases, as the teeth, probably from long disuse, have a very slight hold in the jaw and are very easily shelled out like grains of corn from the cob. It is better to hold the head firmly and depress the chin until a mouth gag can be inserted between solid molars—rather than attempt to pry open with any instrument between the front teeth, or better still, to depend upon expansion screws to be used later between molar teeth.

I do not favor the interposition of any extraneous substance between the divided bones, although I know that Baer, of Baltimore, has had excellent results in this way. If a rather wide section of bone (five-eighth inch) is removed and the articular end shaped to a rounded point, I do not believe this is necessary. The greatest danger of recurrence would seem to be from callus forming and attaching the anterior border of the ramus to the zygoma, and I believe this is avoided by cutting out more bone anteriorly.

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This has been proved, I think, by the end-results in my first three cases where nothing was interposed. However, in doing the Murphy operation, it is so easy to turn down a flap of temporal fascia that I favor it as an extra precaution, and have done it in the last three cases.

In conclusion, I would say that the results in my first three cases, after a period of four to six years, are all that could be desired. They have all been recently heard from and are able to separate the front teeth an inch or more, eat without difficulty, and are highly pleased. In the last three there were no accidents and the results so far are very satisfactory.

A brief record of all my cases is appended.

CASE I.—I. E., male, Italian, aged thirty-seven years. Admitted to the Emergency Hospital July 26, 1915. *Previous History.*—When about twelve years old the patient had a fall, striking his chin and injuring his jaw. Since that time he has been unable to open his mouth or chew solid food. Until five years ago there has been very slight movement in the joint; but he was able to eat only by putting food in through a gap where two incisor teeth had been removed, and mashing it with his tongue against the roof of his mouth. But for the last five years there has been no motion at all of the jaw.

Present Condition.—Rather small man, fairly well nourished and normal in all respects except the absolute rigidity of the jaw and the retracted chin, which always follows injury to the neck and head of the mandible. He is extremely anxious to have an operation done for his relief, and says he would rather be killed than live in his present condition. Röntgenograms showed a massive bony ankylosis of both sides.

Operation (July 28, 1915).—A vertical incision was made a half inch in front of the auditory meatus extending from the upper border of the zygoma downward about an inch and a half. From the upper angle, the incision was carried transversely across the cheek for an inch and a quarter. The bone was exposed, care being taken to avoid the parotid gland and Stenson's duct. It was impossible to find any line of demarcation between the ramus and the zygoma, or base of the skull. The ramus was an inch and a half wide and was finally exposed low enough down to find a free edge anteriorly and posteriorly. A flexible retractor was then inserted under the ramus and it was cut away with gouge chisels without hammering, and pointed at the articular side somewhat like the normal head and neck. A flap of periosteum was turned down from the zygoma and inserted between the cut bone surfaces. The same operation was then done on the other side; but a piece of the parotid gland was cut off and the internal maxillary artery wounded by a slight slip of the chisel. Bleeding was controlled temporarily by gauze packing, and after the bone had been cut away the artery was tied by passing catgut in a small curved needle under it. The periosteum was so thin over the zygoma that no satisfactory flap could be obtained. The wounds were closed and the jaw found

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slightly movable but still quite rigid on account of muscular contraction. Attempting to pry open the teeth resulted in knocking out three or four before it was found that they were extremely loose from disuse and shelled off as easily as grains of corn from a cob. Finally a mouth gag was placed in between two moderately firm molars and an inch cork put in between the jaws in front.

The next day this cork was removed and it was found that the patient could open and close his jaw to the extent of about a half an inch. Later by the use of gradual dilatation with ordinary lead expansion screws such as are used by carpenters, the range of motion was increased to one inch, and when last seen sixteen months after operation the range was one and one-fourth inches.

Cutting the parotid gland caused a salivary fistula on one side which did not completely heal for seven weeks; otherwise convalescence was normal and the scars, when last seen, were hardly noticeable.

CASE II.—D. D., white male, single, aged thirty-two years. Admitted to the Emergency Hospital on February 12, 1916. *Previous History.*—When about ten years old, the patient fell from a cherry tree striking on his chin. After recovery from the acute injury the jaw was very stiff and sore, and this rigidity increased until he was unable to eat solid food. A year or so later he was taken to a hospital where the jaw was opened forcibly under an anaesthetic. This gave temporary relief, but in a few months the condition was worse than before. Several years later he was again taken to the same hospital and another attempt was made to break up the ankylosis by forcible dilatation under ether. This time the attempt was not successful and several teeth were knocked out in the attempt to pry open the jaw.

After that there was complete immobility. As in the previous case, food was introduced through a space left by the loss of an incisor tooth and masticating with the tongue.

Condition on Admission.—Tall, slender, very intelligent young man, with the usual receding chin and complete immobility of the jaw. He was pale, not very well nourished, and very sensitive about his condition. An excellent series of röntgenograms was made by Dr. Thomas A. Groover, showing the usual bony mass about the mandibular articulation on the right side; but the left articulation seemed nearly normal. The chin was drawn slightly toward the affected side, and the cheek on that side was fuller and more rounded. This corresponds to Doctor Murphy's observation that the best-looking side is the affected one, in unilateral cases. This is due to the shortening of the ramus at the point of fracture or disease. The patient had several badly decayed teeth, but had never had toothache.

Operation (one hour after admission, February 12th) was similar in all respects to that described in Case I, except that it was done on the right side only, and without accident of any kind except cutting off a small piece of the parotid. The operation was much

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facilitated by passing the curved handle of a bone forceps behind the ramus, first on one side and then on the other, and boring out the bone with my cranial drill. No flap was interposed, but the articulating end of the ramus was cut to a rounding point. After section of the right side the jaw was found movable and pried open about an inch, very carefully with a pair of Goodell uterine dilators, one on either side between the molar teeth. This was done to stretch the muscles which were much contracted.

After-treatment.—There was no special after-treatment for a week. Then I turned the patient over to my dentist, Dr. A. B. Cooper, who gave him the expansion screws and later small dental jack screws and taught him how to use them himself, and how to tighten them up a little more each day as the muscles relaxed. He wore them mainly at night, with a silk thread attached to prevent swallowing them during sleep. At the end of three weeks he could open and close his mouth without discomfort, almost to a normal degree. The range of motion is now an inch and a quarter, and the patient has a new set of teeth. The wound healed readily, except for a small salivary fistula which persisted for six weeks but did not necessitate confinement. The patient sat up on the third day and was comfortable and was discharged from the hospital on the tenth day after operation. He is now well, eating without difficulty and about the most pleased patient I have ever had.

CASE III.—Miss D. J., female, white, aged twenty-two years, single. Patient of Dr. A. R. Shands. Admitted to the Emergency Hospital September 14, 1916. *Previous History.*—The patient had had an acute suppuration of middle ear following measles when four years old. The ear-drum burst and drained for some weeks and was followed by soreness and stiffness of the jaw, which finally became fixed and has remained so for eighteen years.

Condition on Admission.—A very intelligent young lady, of medium size, well nourished, but with soft muscles. No teeth had been lost, but the lower jaw was so much retracted that the lower incisors were half an inch back of the upper incisors, leaving a gap through which food was introduced. Jaw absolutely rigid. Chin drawn slightly to right side and right cheek fuller than left. Röntgenograms made by Doctor Groover showed heavy mass of bone about right mandibular articulation and left joint apparently normal.

Operation (September 15th) by Doctor Shands, with my assistance. Doctor Shands attempted to operate through a straight transverse incision over the zygoma, but was obliged to make an L running down a half inch in front of the ear in order to get sufficient room. The bone was cut as in the previous cases with cranial drill and gouge chisel, without hammering, and trimmed with bone forceps. Immediately on section of the bone there was a wide separation and the mouth opened easily an inch and a half. A small piece of parotid gland was cut off in spite of our care to avoid it. No flap was used between the cut bone surfaces.

After-treatment.—No special after-treatment was used. The

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muscles were not contracted as in the previous cases and the young lady was able to eat in a few days without discomfort. The wound healed readily except for a small salivary fistula which had almost entirely healed when she returned to her home in North Carolina in November, 1916.

I advised Doctor Shands to teach her to use the expansion screws and have her use them on the slightest sign of recurrence, but so far it has not been considered necessary.

CASE IV.—L. C., male, white, aged twenty-seven years, single. Referred by Dr. Thos. Grasty, September 19, 1917. *Previous History.*—A fall on the chin when five years old. Jaw has been rigid ever since he can remember. Usual deformity.

Condition on Admission.—Complete fixation of the jaw with the usual deformity seen in one-sided cases. Murphy operation at the Emergency Hospital September 22, 1917. Flap of temporal fascia stitched between the severed bones. Rigid muscles stretched with mouth gag between molar teeth. Primary union. Patient reported September 30, 1920, three years after operation. Result excellent. Opening one and one-quarter inches.

CASE V.—Female, colored, aged eighteen years, single. Referred by Doctor Bailey. *Previous History.*—Fall on chin when fourteen years old. This was followed by severe pain, soreness and swelling of jaw on left side.

Condition on Admission.—Stiffness increased gradually to complete rigidity in about a year. Usual deformity. Murphy operation at the Emergency Hospital April 12, 1918. No accident or complications. Mouth opened easily. Result excellent after two and one-half years.

CASE VI.—Miss A. J. N., white, single, aged thirty-seven years. *Previous History.*—Abscess near the maxillary articulation following diphtheria, when a small child.

Condition on Admission.—Seen first in September, 1920; had the usual rigidity and deformity; jaw rigid ever since she could remember. Has very bad teeth with abscess at the roots of several and X-ray shows two impacted molars on the affected side. Upon consultation with her dentist, Dr. A. B. Cooper, it was decided to remove all her teeth at the time of operation.

Operation at the Emergency Hospital, October 18, 1920. Murphy operation. Extraction of teeth by Doctor Cooper. No accident or complication except that the teeth were very difficult to extract. Several broke off and the roots were dug out with an elevator. She complained greatly of pain where the teeth were extracted for some time and of great soreness of the gums. Also complained of a discharge from the ear, which Doctor Piggott (her ear specialist) said was due to an old middle-ear disease with perforation of the drum. She had no pain in the operative wound which healed *per primam*. She was much pleased with the result of operation and when last seen, a month later, had quite free movement.

LARYNGEAL FUNCTION IN THYROID CASES*

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THE larynx takes part in two functions, phonation and respiration. Phonation is brought about largely by the adductor muscles of the vocal cords which in contracting approximate the cord in the midline. During normal respiration the vocal cords are held apart by the abductor muscles (Figs. 1 and 2). All the intrinsic muscles receive their nerve supply from the recurrent laryngeal nerve and any disturbance in the function of the larynx is apt to be the result of some form of disturbance of this nerve. It is situated so that it is exposed to pressure from aneurisms in the upper portion of the chest and to pressure from enlarged lymph-glands, and as a result of this pressure it is not uncommon for the nerve on one side to become partially or completely paralyzed. In the absence of any pressure or trauma this nerve may be paralyzed occasionally, probably as a result of some toxic influence. Because of the gradual onset of this form of paralysis the patient may not be aware of any change in the function of the larynx and may continue to speak and breathe in a normal manner. This is explained by the fact that as the muscles of one vocal cord become less active because of the interference to their nerve the muscles of the opposite cord increase their function, enabling the normal cord to make excursions across the midline of the larynx and approximate the cord at that point. So long as the change is brought about gradually the patient is not aware of it, but if one side is paralyzed suddenly loss of voice and difficulty in breathing will be experienced until, by repeated efforts, the muscles of the good cord bring it across to an exaggerated position. Matthews, working in our clinic several years ago, found that a small percentage of patients on whom he made laryngoscopic examinations had almost total paralysis of the vocal cord, and that in addition a larger percentage showed some paresis of one cord. This occurred in patients in whom there was no enlargement of the thyroid and who were totally unaware of any change in laryngeal function.

As the recurrent nerve passes upward in the groove between the trachea and the oesophagus and reaches the region of the thyroid, it becomes intimately associated with the posterior capsule of the thyroid gland and in reality is compressed between the gland and the tracheal and cricoid cartilages. It can be seen readily that any enlargement in the thyroid is apt to make pressure on this nerve and that if the pressure becomes great enough it may cause disturbance in function. The size

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of the gland is not always accountable for the pressure, for there may be no sign of disturbance in the case of a large tumor, and a marked disturbance may result from a small goitre placed so as to exert the greatest pressure on this nerve. Paralysis of the recurrent laryngeal nerve

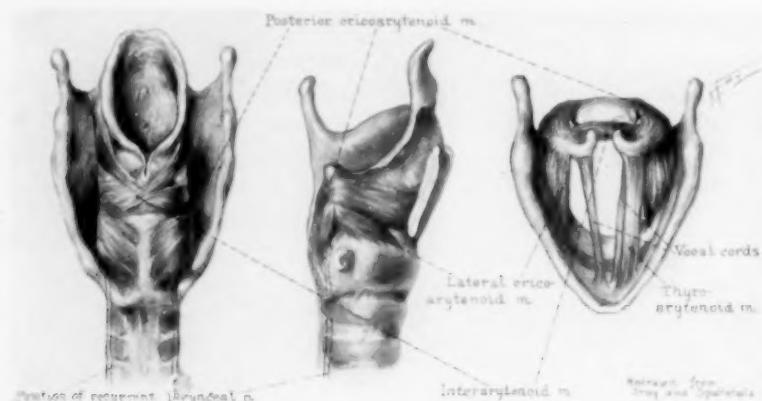


FIG. 1.—Muscles of the larynx.

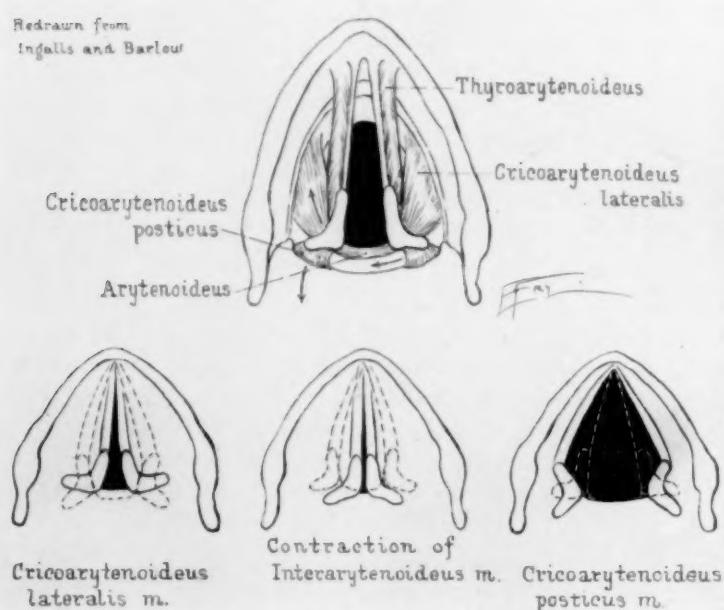


FIG. 2.—Action of the muscles of the larynx.

caused from a goitre apparently occurs in somewhat more than 5 per cent. of all patients with goitre. A very interesting condition occurs in a smaller percentage of cases, namely, a paralysis in the nerve on the side opposite the enlargement. A large adenoma of the right lobe may

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cause a marked displacement of the larynx and trachea, and if the proper amount of pressure or stretching is exerted on the opposite nerve paralysis is produced.

When we realize that a certain number of persons without disturbance of the thyroid have paralyzed vocal cords and also that a patient with goitre may have paralysis on the side opposite the enlargement, the importance of a careful laryngoscopic examination before operation for goitre becomes evident. If a patient is depending on one cord for phonation and normal respiration it is important to protect that cord.

Total loss of voice in association with enlargement of the thyroid is due to one of two conditions, hysteria or carcinoma. At least I have not seen a case in which benign enlargement was the cause of bilateral paralysis. If the condition is due to hysteria, some motion of the cords will be discernible with the laryngoscope, and this motion is due to the adductor contractions. If the cords are completely paralyzed the condition is almost certain to be carcinoma. In benign enlargement we have to deal only with pressure and stretching of the nerves and with disturbances of the intrinsic muscle from these causes; in malignant disease the process is not confined within the capsule of the thyroid, but involves the nerves and causes an actual destruction of nerve tissue which results in a total paralysis.

Temporary disturbance in the voice and respiration is not uncommon following thyroidectomy (Guthrie). I believe that the loss of voice soon after operation may be due to one or more of the following factors:

(1) A change in the position of the muscles and cartilages because of the shifting of a misplaced larynx back into its normal position; (2) œdema of the tissues; (3) a true myositis; (4) trauma to the recurrent laryngeal nerve; and (5) prolonged interference with function.

1. *A Change in the Position of the Muscles and Cartilages Because of the Shifting of a Misplaced Larynx Back into its Normal Position.*—In several cases in which an adenoma was large and situated so as to push the larynx off at a right angle, no view of the larynx could be obtained with the laryngoscope; I noticed that when the tumor was removed and the larynx allowed to return to its normal position the voice was lost immediately and returned to normal in from a few days to a few weeks.

2. *Œdema of the Tissues.*—This is more marked in some cases than in others, and is, I believe, less common now than formerly, because we realize the importance of keeping the line of dissection farther away from the trachea and larynx and of saving more tissues about these structures to prevent the swelling from extending to the mucous membranes.

3. *A True Myositis.*—Myositis may result from trauma to the muscles and cause limitation of motion of the vocal cords, or an ankylosis of the joints between the cartilages of the larynx may occur. The delicacy of the laryngeal structures makes it impossible to determine just how often these lesions occur.

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4. *Trauma to the Recurrent Laryngeal Nerve.*—I am under the impression that the nerve is more often injured at the point of entrance into the larynx than at the point of crossing the inferior thyroid artery. The nerve is seldom severed, but it may be pinched in the haemostat with other tissue or it may be caught in a ligature in tying a vessel.

In 1917, Mann, New, and I traumatized the laryngeal nerves in dogs to study the return of function. In twenty-four cases the nerve was pinched and all the cords were paralyzed. After pinching the nerve at the lower pole of the gland the function was restored in about sixty days, after pinching it close to the larynx function was restored in thirty days. In all cases there was complete restoration of the laryngeal function. In another series of nineteen cases the nerves were ligated. Plain and chromic catgut and silk for the ligatures were used, and in each instance immediate and complete paralysis occurred. These dogs were observed for one hundred and sixty days; during this time there was no sign of any return of function. In several instances in this series the nerve was severed, always with complete and permanent paralysis. In nine of the series the nerve was stretched for a few minutes, but in one case only was there any paralysis from this procedure. In four cases the nerve was stretched by suturing the muscles under them, thus producing a permanent constant stretching. In three of these paralysis occurred.

It seems to me that these experiments gave results that would be expected; that is, that if the nerve is severed or tied tightly, even with catgut, the ensuing paralysis will probably be permanent and the function will be disturbed until it can be compensated by the increased efforts on the opposite side. If the nerve is pinched or stretched or explored, the paralysis will be temporary and the function restored by recovery of the traumatized nerve.

Injury to the superior laryngeal nerve naturally is an uncommon occurrence. This nerve supplies sensation to the mucous membrane of the larynx and a branch to the external muscles which, in contracting, make the cords tense. An injury to this nerve would produce a numbness in the larynx and a lax cord with a deep, coarse voice.

The complete restoration of phonation and respiration to normal occurs with restoration to normal of the muscle and cord on one side. Even if the nerve has been severed or destroyed completely, or if one cord has been removed, the function eventually returns, due to the compensatory efforts of the uninjured cord, so that while any trauma to a recurrent nerve is serious, the effects so far as function is concerned will be only temporary. Serious results occur if the only nerve that is functioning is interfered with or if both nerves are traumatized. We have performed a great many thyroidectomies during the course of a number of years, and have observed many patients with some disturbance of phonation, of respiration, or of both at various periods, often within a few days after the operation, but the voice and breathing have always returned

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to normal except in a small group of cases. In a few instances some evidence of trouble persisted for a month or more, but finally ended with a normal laryngeal function. These patients are restored to normal voice through the increased efforts of the normal cord. In cases of paresis recovery occurs.

5. *Prolonged Interference with Function.*—A small group of cases of bilateral abductor paralysis (twelve cases) prompted this study of laryngeal function. The voices of these patients are usually normal or may be very slightly impaired; the principal disturbance is in respiration. In approximately 25,000 thyroidectomies we have had nine patients with this trouble; three others were observed who were operated on elsewhere. A few scattered cases have been mentioned in the literature. It is interesting to note that this condition has been observed independent of any condition of the thyroid, and in such instances was believed to be due to toxic influences (Gleitsmann²). Bilateral abductor paralysis is not uncommon with syphilitic and tabetic conditions. It is possible that some of the cases of complete dyspnoea which occur at the time of the operation or a few days afterward are due to recurrent paralysis, although if the paralysis is complete there will be no trouble in breathing. These occurrences are rare, although at times they are severe enough to require immediate tracheotomy. After the acuteness of the symptoms has subsided, usually within a few days, the tracheotomy tube can be removed, and the opening in the trachea allowed to close. The return to normal of the voice and respiration will take place in a short time. These cases may or may not be due to disturbance in the cord, but the onset of the condition is so abrupt that no time can be taken for laryngoscopic examination.

The onset in these twelve cases of bilateral abductor paralysis was gradual. The immediate convalescence from the operation in this group was not unusual, except that the voice was weak and husky. In some of the cases there was paresis of the cord after the operation, although it was not sufficient to produce a noticeable change in the voice or in breathing, except in two or three cases. In a few cases there was some hoarseness and huskiness immediately after the operation. At the end of four or six or even eight weeks dyspnoea appeared and gradually increased. The voice remained normal. The degree of dyspnoea varied. Although usually a tracheotomy does not seem necessary, in four of these cases the margin of safety for a sufficient amount of air was considered so slight that operation was performed in two cases in the clinic and in two cases elsewhere, one after six months, one after seven months, and one after fourteen months following the operation. The paralysis, if it is a paralysis, is confined to the posticus muscles which are the abductors of the vocal cords. New has demonstrated that there is no ankylosis of the joints of the cartilages. We have not been able, however, to show that there is not a myositis in this muscle. The paralysis occurred for the most part in cases in which the adenomas were retrotracheal or retrolaryngeal, in which case the recurrent laryngeal nerve is liable to be in the field of

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operation; also possible that in the removal trauma occurred to the posterior tissues of the larynx. Although it seems that this condition must be the result of some change in the nerve to these muscles it is difficult to understand just how it can occur. Any manner of traumatizing the superior or inferior laryngeal nerve in dogs does not produce a condition anything like a bilateral abductor paralysis. Because the onset is late the explanation has been offered that the contraction of scar tissue produces pressure on the recurrent. This is entirely feasible, since the fibres of the recurrent laryngeal nerve which supply the abductor muscle are known to be the most vulnerable part of the nerve. The condition, however, is bilateral and always of the same degree on both sides. In some of the cases almost all of the operative work was on one side only, so that there was no chance of trauma to both nerves, and it seems unlikely that the same amount of scar tissue should occur on each side. New has suggested that at the time of the operation injury to the nerve may be serious enough to produce interference with abduction and with adduction (the immediate disturbance of the voice in all but one case bears this out), and that the nerve recovers partially so that the voice becomes normal, but that the portion of the nerve which has to do with breathing does not recover.

The recurrent laryngeal nerve is a pure motor nerve coming from the vagus. It is small but in spite of this can be separated into two distinct bundles of fibres (Russell). One of these bundles supplies the muscles of adduction and the other the muscles of abduction. These fibres run in separate bundles throughout the whole course of the recurrent nerve; those for abduction are on the inner side of the nerve trunk, and those for the adduction on the outer side. They may be dissected to such an extent that one set of fibres responds to electric irritation exclusively by adduction of the vocal cords and the other by abduction. Rosenbach was the first to proclaim that the abductors suffer first from compression of the recurrent nerve. Semon proved, however, that the important pathologic condition is seen not only in local lesions along the cords but also in central cerebral diseases as well as in spinal diseases of an organic nature. Grabower found that the posticus muscle has on the average 281 terminal nerve fibres and the adductors have 680, and he believes that this may explain why the abductor muscles are the first to be affected. If it could be explained how the scar tissue affects both nerves in exactly the same way, the contraction of this tissue on the recurrent laryngeal nerve might explain the condition, especially in view of the fact that the onset is gradual. If it is due to the contraction of scar tissue it is difficult to explain why it is not much more often seen. We have been unable to simulate the condition experimentally. It is entirely possible that it is the result of some toxic influence on the nerve, and yet it is hard to explain why such a small percentage of cases are influenced by it. In the few cases we have seen it has usually occurred in patients with non-toxic goitre, so that the toxæmia of hyperthyroidism could hardly be responsible.

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Discussion.—Although cases of bilateral abductor paralysis following thyroidectomy are extremely rare, they are so serious that they deserve a great deal of consideration. We have observed that the condition progresses until there is considerable difficulty in breathing, especially on exertion, and from then changes are slow. In none of our patients has phonation been affected except from dyspnoea; after a long time the tendency seems to be toward improvement.

Tracheotomy may be necessary because of the small margin of safety, although so far as we have been able to determine there is no danger of acute suffocation. The cords are held in adduction by the contraction of the adductor muscles, and it is probable that these muscles would relax enough to allow the entrance of air in case of any suboxidation.

For the treatment of these cases other than tracheotomy we have considered the advisability of dissecting the recurrent laryngeal nerves from the scar tissue, in the hope that by freeing them the pressure of the contracting scar might be relieved and enable the nerve to functionate normally. We have also considered performing a plastic operation on one vocal cord in order to give more breathing space, but we have hesitated to do this because of the fear of interfering with the voice. Usually when this is explained to the patient he prefers not to take any chance on having phonation disturbed.

It may be said in conclusion that (1) the functional results following thyroidectomy both as concerns phonation and respiration are extremely good; (2) the disturbance which sometimes follows immediately after the operation is temporary, and normal function will be restored in from a few days to a few weeks; and (3) there is a very small group of patients who, following thyroidectomy, have a bilateral abductor disturbance which is slow in onset but is very persistent. We have been unable to work out the cause of this condition, but believe that it may be due to the contraction of a scar, to a peculiar type of trauma to the nerve, or to some form of toxæmia.

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GASTRIC AND DUODENAL ULCERS*

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THE accident of peptic ulcer, for such I believe it to be, is rare; it represents but a fraction of 1 per cent. of the findings of general necropsies. In the aggregate, however, the condition occurs in thousands of persons, many of whom apparently never suffer from symptoms of gastric trouble; others do not appreciate the symptoms. Undoubtedly some persons have hyposensitive abdomens and experience little reaction from acute or chronic disease; conversely, persons with little pathologic foundation have grave symptoms. In the former the presence of ulcer might first be surmised by hemorrhage, perforation, or obstruction. The majority of persons who have ulcer of the stomach or of the duodenum have well-marked symptoms, almost sufficient from which to make a diagnosis without the corroborative evidence of the röntgenographic or fluoroscopic examination. Peptic ulcer occurs in all climates, apparently with all types of food, and in all races; seasons, spring and fall, increase the symptoms to some extent. During the period when acute and chronic bleeding and perforation and mechanical obstruction were the main diagnostic points of ulcer, bleeding was much relied on in making a diagnosis. These symptoms lost their importance as diagnostic ability improved, and so many cases of ulcer were added to the list that the incidence of hemorrhage was reduced to approximately 20 per cent. in the cases diagnosed.

Peptic ulcer is more common in males than in females, the proportion being three to one. The proportion of gastric to duodenal ulcer is approximately one to four, as shown by reports from the Clinic, where from January 1, 1906, to January 1, 1920, operations were performed on 1191 patients with gastric ulcer and on 4532 patients with duodenal ulcer. A very small percentage of patients have ulcers in the stomach and in the duodenum; in only 203 instances during the fourteen years were both gastric and duodenal ulcer found in the same patient. In a series of 638 patients with gastric ulcer observed in a five-year period, twenty-eight had multiple ulcers; Sir Berkeley Moynihan has called attention to the occurrence of this condition.

As to the etiology: I believe that peptic ulcer is undoubtedly developed by a combination of local chemical effects, possibly causing prolonged vessel spasm or claudication, a counterpart of Raynaud's disease or scleroderma, or by direct interference with the circulation through infarction emboli of bacteria, chemically and mechanically active in the tissues and thereby lowering the local resistance to the action of digestive

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fluids. The two, a changed circulation and peptic action, are most surely associated early. In the diseased tissue, during the periods of varying activity and remissions of chronic ulcer, bacteria can be cultivated from excised ulcer tissue which has been made wholly free from surface contamination. If the cultures grown in such experiments are injected into animals similar ulcers are produced in a high percentage of cases. Rosenow has shown the bacteria cultivated from the tissue of an excised ulcer of the stomach to be the same as those cultivated from the abscess around the root of a tooth. The cultures from each repeatedly injected intravenously produced ulcer of the stomach. A like condition was produced experimentally by cultures from a blind abscess pocket in a small uninflamed tonsil in one other case. In the chemistry of the bacterial products, I believe, lies the explanation of the chronicity of the disease. That ulcer is not produced by traumatism is the testimony of surgeons who operate on persons who have accidentally swallowed sharp or hard substances, and on the insane who have swallowed their table cutlery, nails, hairpins, and similar undigestible material. Ulcer is rarely produced by direct external traumatism; if it were, the greatest difficulty would be experienced in healing incisions for gastrotomy or gastroenterostomy, as in securely adjusting the approximation against leakage and hemorrhage devitalization by suture of the incised area is an essential in the operation.

Practically all ulcers of the duodenum occur in the first portion between the entrance of the common duct and the pylorus, which should be called the antrum or vestibule of the intestine. In this space the acid chyme which is still active with pepsin is held until it is neutralized in the area of Brunner's glands by a secretion apparently called forth by the presence of food in the stomach and not by the acid, although the action is evidently neutralization and preparation for alkaline digestion. The loss of harmony of action in the neutralization process may be an added factor in some cases in the occurrence of ulcer and recurrence of ulcer symptoms. Cannon showed the closure of the pyloric ring to be due to acids. When the acids in a bolus are neutralized the muscle relaxes and the next bolus escapes from the stomach; the gastric peristaltic waves are ineffectual until neutralization is complete. If this observation were not correct, peptic ulcer could occur in diminishing numbers down the upper intestine, since the neutralization of the acid chyme could be accomplished and intestinal digestion continued by an extravagant waste of the digestive alkalies of the upper intestine and glands. Ulcers occasionally appear in the new opening. With cholecystostomy an open pylorus is maintained by the alkaline bile, although nothing leaves the stomach without peristaltic action. The same condition is present in achlorhydria. External pressure on the stomach is seen easily to force the barium into the intestine.

Reeves and others have shown that the anatomic arrangements of the

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arteries along the lesser curvature of the stomach, in which parallel arterioles supplied at both ends by arterial majors give an opportunity for some stasis, and a triangular supply throughout the first two inches of the duodenum predispose to thrombosis. Should certain bacteria be present in the blood supply they may as emboli destroy a local area of circulation. Tissue infiltrated with bacteria by chemical action may prevent healing. The relationship of pepsin and acid has always been recognized as associated with the development of these so-called peptic ulcers. The surface ulcers on the mucous membrane may be produced experimentally in numbers by certain toxic materials, other than bacterial, injected into the circulation or administered by mouth, but such ulcers are fleeting; they are not considered in this discussion.

Doctor Sippy, of Chicago, one of America's greatest internists, should be credited with having done the most to coördinate medical thought with regard to the condition of gastric ulcer and its medical treatment, which is based on changing the environment of the ulcer area by controlling the corrosion of gastric acids during exacerbations. He has shown that the combined acids have little to do with activating pepsin during the period ordinarily given for digestion, and that free acid is the activating agent. The medical treatment of gastric ulcer in an exacerbation during waking hours is directed toward controlling and lowering this acidity by dilution or neutralization of gastric contents at regular periods. The food, such as milk and cream, which is permitted during one period has a fairly high percentage of fat which delays digestion; the next period is given to alkalies. This procedure is carried on while the patient is awake and in bed, while the symptoms are acute. Patients are under surveillance for a long period, with repeated tests of the stomach's content and a regulated diet. Such treatment, although effective at least in affording relief, can seldom be obtained by the majority of those afflicted; the patients may be too poor, or for other reasons so situated that they cannot secure the treatment. Because of the years of disability patients with recurring attacks who are cared for in hospitals and out represent a fairly high percentage of gastric ulcers as compared with other diseases. Freedom from symptoms following an attack does not necessarily mean a healed ulcer; however, it must be said that some patients are relieved medically to their satisfaction. While patients are being cared for during many years of recurring attacks some develop conditions, such as hemorrhage, obstruction, and perforation which demand immediate surgery, and not a few develop cancer or ulcer, of which approximately 25 per cent. remain confined to the stomach (a local disease) until death occurs. Ulcer of the duodenum, however, rarely develops into malignancy.

Judging from the literature on this subject, presented by the internist and by the surgeon, there would seem to be a wide divergence of opinion with regard to the condition and its results. Personal conversation with some authors, however, shows that considering their viewpoint, it is not

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so dissimilar as appears from the emphasis placed on certain conditions and symptoms. The internist, in urging medical care, refers to the danger of surgery. In the 4532 cases of duodenal ulcer the operative mortality was but 1.76 per cent.; death naturally occurred in the more severe long-neglected and complicated cases of obstruction, perforation, or hemorrhage, while in the 1191 cases of gastric ulcer the mortality was 3.77 per cent.; but all physicians admit the greater seriousness of the latter condition. Again, the internist refers to the rare bad results, largely avoidable, such as the vicious circle and gastrojejunal ulcer. It is true that some surgeons perform gastroenterostomies because of symptoms, for example, digestive reflexes, abdominal and even spinal, without positively determining the presence of the ulcer. In a number of cases, to the discredit of surgery, it is necessary to cut off and close the gastroenterostomy which was made, although no ulcer was present, the patient being far worse than before the operation. In this manner we have dealt with a few hundred cases in which the gastroenterostomies had been made, based on symptoms alone, since the presence of the ulcer had not been proved. Fourteen of this group of patients had been operated on in our own Clinic in the early developmental period of gastric surgery when abdominal examinations were less thorough, on the surmise that they were suffering from ulcer on the posterior wall of the stomach. The surgeon, on the other hand, appears to discredit the internist, as he never sees an ulcer in the early stage unless it has perforated or is causing hemorrhage; he thus may exaggerate the danger of ulcer. All except emergency patients are treated by many physicians for long periods before they receive the benefits of surgery, and again the surgeons frequently find that they are giving surgical intervention not for ulcer, but for secondary conditions with varying symptoms of gastric disturbance which are not caused by ulcer, but are the response of the stomach in pyloric spasm induced by disease of the appendix, more commonly disease of the gall-bladder, or more rarely disease of the pancreas. Although the patients may have passed years in the active care and treatment of their stomachs, the gastric trouble is reflex in origin. Nevertheless, the patients need surgical treatment.

In the diagnosis of gastric and duodenal ulcers much attention is paid to the history given by the patient of attacks with intervals of health. The relief obtained by taking food, fluid, or alkali and the relationship in time of appearance of symptoms to the last meal are of importance. Qualitative food dyspepsia rarely is associated with ulcer, but represents a gastric reflex appearing within a half hour after food is taken, while quantitative food dyspepsia is usually associated with interference of peristalsis which, if intestinal, appears at the end of one hour. Surgery is usually indicated for relief, but not necessarily surgery of the stomach, for hemorrhage (vomited and by bowel) may come from gastric erosion, from the liver, the pancreas, or from rupture of veins within the stomach

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caused by splenic disease. In about one-fifth of the cases of true ulcer hemorrhage is a symptom, but little attention is paid to occult blood except in unusual conditions. It is of interest, however, that in a large series of our early cases of gastric ulcer about one patient in four had had hemorrhage before operation and one in twelve suffered from hemorrhage afterward. This is an additional reason for destroying the ulcer which we strongly recommend as well as making the gastroenterostomy, since if destruction of the ulcer alone is sufficient to cure, natural perforation and its healing should theoretically cure. Perforation, while not common, does occur, without relieving symptoms, however, and unless it occurs as a primary symptom it is not so serious as is generally believed, since nature usually affords protection by immediate stasis and adhesions.

Great reliance is placed in the X-ray to corroborate the clinical history and general diagnosis of the condition. Carman and his co-workers in the Clinic who have wide experience in such cases are able to make the diagnosis from the X-ray standpoint in 95 per cent. The importance of the X-ray is very great in determining whether the ulcer is gastric or duodenal, which is often difficult or impossible clinically.

We agree with Sippy that control of the acids limits peptic activity and gives relief of symptoms, but we also agree with Moynihan that treatment but tides the patient through the exacerbation and does not cure permanently. One or two years between attacks without treatment is a common early history. A gastroenterostomy, however, permanently applies the medical principle of treatment by overcoming the effects of pyloric spasm, preventing retention of gastric secretion after food has left the stomach, and by allowing sufficient quantities of the alkaline secretion of the duodenum to pass into the stomach to lower the general acids. This fact was first called to our attention by Paterson. Lemon, in a series of 200 cases in our Clinic, showed the reduction in general acids after operation to be 39 per cent., and in free hydrochloric acid 46 per cent. The change in the local environment apparently often permits nature to heal the ulcer as well as to overcome symptoms. The retention of a considerable amount of secreted acids in a stomach free of food indicates a pyloric spasm and a varying loss of balance between the neutralizing alkalies in the first portion of the duodenum and the acids of the stomach, and herein lies the defect of pyloric operation for ulcer, effective as it may be for spasm; for a time it relieves by removing the control of the gastric outlet, but the acidity is not changed. A high proportion of combined acids as compared with the amount of free acid indicates delay or retention caused by spasm or obstruction. In gastric ulcer the marked lowering or loss of free acid and increase of combined acids may indicate malignant change, although it is admitted that cancer of the stomach occasionally occurs with a high acidity. The same change in acids, lowering of free acid and increase of combined acids, is often found associated

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with pyloric spasm secondary to cholecystitis and pancreatitis. Achlorhydria is seldom changed by medication or surgical intervention; certainly gastroenterostomy is not indicated. Do all cases of ulcer require operation? In some instances in a routine general examination ulcer of the duodenum is found without appreciable symptoms. Frequently we do not operate in such cases, but we inform the patient of his condition, direct him to live with greater care, and advise him that operation will be necessary if certain symptoms arise, or if the routine of life is deranged by such special care. In the earlier stages of duodenal ulcer destruction by cautery and closure is effective at least for a time. A number of such cases have been observed in the Clinic. In ulcer of the stomach with low acidity this procedure may be successful, but with high acidity and greater spasm gastroenterostomy is indicated even after excision or destruction of the ulcer. I believe that the excision or destruction of ulcer of the stomach, even if it gives but few symptoms, is indicated regardless of the degree of acidity. Should gastroenterostomy always be made after destruction or removal of ulcer of the stomach? In some cases, in which the symptoms are only occasional and of short duration with long intervals of health, the closure of an acute perforation is all that is required, as in them the acids are low.

In a study of the results of 647 operations performed in the Clinic on 638 patients with calloused ulcer of the stomach from July 1, 1914, to July 1, 1919, the average mortality was 3.2 per cent., more than double the average mortality in 2734 operations performed in the same period on 2720 patients with duodenal ulcer. Five hundred and thirty-four ulcers were located on or around the lesser curvature, eighty-five on the posterior wall, nine on the greater curvature, and five on the anterior wall; the location of five was not definitely recorded. Of those on the posterior wall 8.2 per cent. were in the pyloric third, 73.3 per cent. in the middle third, and 16.5 per cent. in the cardiac end. All were of the chronic perforating variety and fifty-three were attached to the pancreas and involved it in the ulcerative process. Fifty-seven of the eighty-five patients were males and twenty-eight were females; their ages varied from eighteen to sixty-nine; the average was about forty-four; the average duration of symptoms was six and one-half years.¹⁰ Investigations for many years at the Clinic have led us to reiterate the assertion that gastric ulcer is potentially malignant, although by a post-mortem examination of extensive disease causing death it may be impossible to determine that an early ulcer was present. Many ulcers that we believed to be benign and excised showed the presence of carcinoma in a limited area of the margin. We believe that Aschoff is correct in his assertion that if the lesion is cancer originally the base of the ulcer will prove to be cancer, but in a few cases the cancerous area was in the margin only, and we therefore believe cancer often develops on ulcer, and hyposensitive stomachs obscure early symptoms.¹⁴

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Balfour, on the theory that malignant cells are much more vulnerable to heat than normal cells, suggested and developed a slow destruction of ulcer by perforation with the cautery and immediate closure and gastro-enterostomy (Fig. 1).

In the removal of perforating ulcers of the posterior wall of the stomach attached to the pancreas we use the upper approach through the gastro-hepatic omentum. The finger is hooked around the attached ulcer area and the ulcer shaved from the pancreas, its margins are cut away with a knife or cautery, and the opening closed with chromic catgut sutures. To protect and mobilize this area of the stomach a gastrocolic omental opening is made between the stomach and the colon, and the margin of the omentum is drawn through the opening and plastered over the posterior wall of the stomach, to which it is fixed by sutures, covering the area from which the ulcer was excised, as well as the pancreas. A posterior gastroenterostomy is also made (W. J. Mayo).

In eighty-nine operations performed in the Clinic for hour-glass stomach the operative mortality was 7.4 per cent. Of the various methods of excision and plastic enlargement of the stomach for the relief of this most distressing condition the sleeve resection of the central portion of the stomach, usually with gastroenterostomy, is performed. If there is a recurrence we remove the lower half at the second operation, uniting the narrowed proximal portion to the jejunum, and sometimes to the duodenum. As a rule, we also make the same type of union of the stomach with the duodenal end or the jejunum for extensive ulceration and thickening, and for local cancer in the pyloric region after resection of the stomach. I first saw the end-to-side union of the stomach and the jejunum in 1912 in Germany and in Austria, where it was called by some the Hofmeister operation, and by others the Enderlin. Later we found it had been described by Polya in 1911. I performed five of the operations in 1913. After division of the stomach the proximal end was drawn through an opening in the mesentery of the transverse colon, to which it was sutured and the jejunum applied to the whole of the cut area of the stomach, a large opening being made and the duodenal division being closed by suture. In some cases this operation gave trouble from traction of the transverse colon on the stomach and, when the operation was performed for cancer, the rich blood supply of the mesentery, if recurrence occurred, caused early obstruction. Balfour obtained a higher percentage of good results by making the same attachment of the jejunum anterior to the colon, and we have adopted this method and found it very satisfactory. In large openings in the end of the stomach I have found additional advantage in partial closure and covering the closed portion with the unopened jejunum by suture. By turning the jejunum to the right a loop of from 12 to 14 inches is sufficient to provide for the drop of the colon; the jejunum, passing around to the left of the sagging transverse colon and coming out of its splenic flexure, receives no pres-

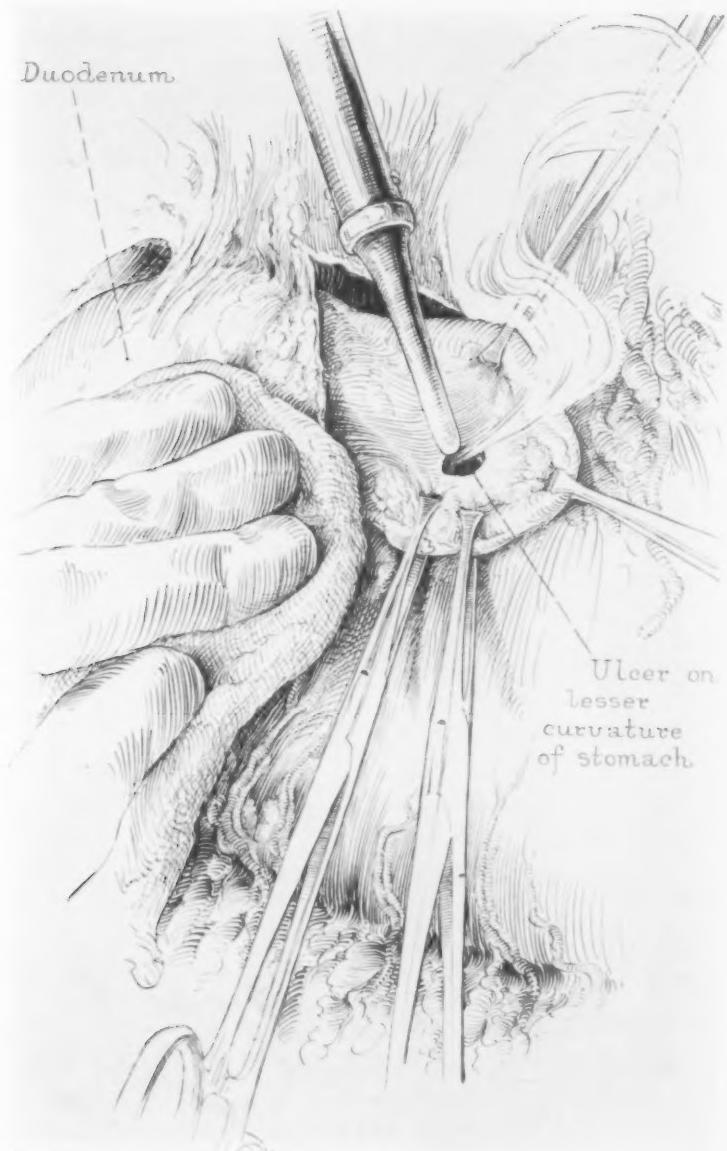


FIG. 1.—Destruction by cautery (Balfour method) of ulcer on the lesser curvature of the stomach.

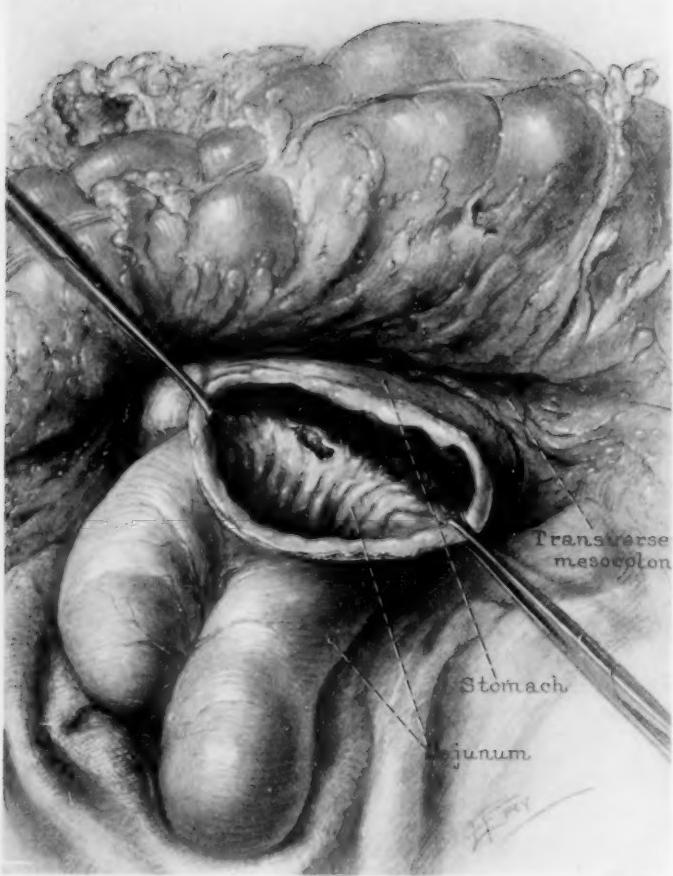


FIG. 2.—Gastrojejunal ulcer on the suture line at the site of an old gastro-enterostomy.

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sure from the colon: isoperistaltic attachment. The surgeon must watch that the first loop or coil of jejunum is not left turned under the attached second loop to cause obstruction. Surgeons who do not turn the bowel also have good results.

Gastrojejunal ulcer is an unfortunate condition which occurs in a small percentage of patients who have been primarily relieved by gastroenterostomy, but their troubles are so continuous or the recurrence of spells so frequent after some months of apparent cure, and they consult so many physicians, that each case apparently stands for a multitude of failures. Such cases do much to discredit the surgical treatment of ulcer, since contraction closes the gastroenterostomy ultimately and possibly the bowel; and many physicians still believe natural closure to be the ultimate fate of gastroenterostomies, although in truth it is a rare condition. But even the present small percentage of gastrojejunal ulcers can be markedly reduced, I believe, by avoiding the use of permanent suture material for the brief period demanded in the ordinary case of gastroenterostomy; undoubtedly it can be lowered still further if more attention is paid to freeing patients of their foci of chronic infection, usually streptococcic, which give the opportunity for new infarctions at the point of gastrojejunal union, often commencing before healing is completed. We admit that silk sutures hang for long periods in the majority of cases without causing ulcer (Fig. 2).

To January 1, 1920, we had operated on eighty-three patients with gastrojejunal ulcer, of which forty-seven followed gastroenterostomies performed in the Clinic for benign duodenal or gastric ulcer, and thirty-six followed primary operations elsewhere.⁶ In a number of this group the permanent silk suture was found hanging in the ulcer's indurated area, and in others it had apparently but recently passed out; in four instances the sutures have been found hanging from the ulcer area and exposed to the gastric fluids four years following the operation, and in a larger number of cases the same condition has been found after shorter periods following operation. In such cases the patient complains much as before the operation, and the trouble is more continuous.

The röntgenogram gives valuable aid in the diagnosis of gastrojejunal ulcer in about 80 per cent. of cases. In three instances we have seen such ulceration perforate the colon and produce a gastrojejunal colic fistula. If the ulcer area is small its excision is advisable; and the opening should be reestablished by catgut suture. In extensive areas of ulceration and partial closure the gastroenterostomy is undone, and the bowel and the stomach closed; in a few cases it has been found advisable to enlarge the pyloric outlet by some of the plastic methods.

Gastric ulcers should receive special consideration because of the seriousness of perforation, the chronic symptoms, the frequent deformity and fixation of the stomach, the not infrequent development of carcinoma, and because the results following gastroenterostomy for gastric ulcer are

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certainly not so good as those following gastroenterostomy for duodenal ulcer. Graham, in an investigation of 438 cases of duodenal ulcer, found that 70 per cent. of the patients who survived operation considered themselves well following gastroenterostomy, 27 per cent. were improved, and 3 per cent. unimproved.

The future condition and length of life of patients with peptic ulcer are problems recognized by insurance companies in considering the applications for insurance of those who have had operations for ulcer. Hunter, Actuary of the New York Life Insurance Company, in an investigation at the Clinic of the results of operation in a large series of cases of gastric and duodenal ulcers, found that the average death-rate for the four-year period after operation in patients with gastric ulcers was slightly more than three times the normal, while in patients with duodenal ulcers it was if anything slightly less than normal. The series consisted of 2431 patients, and all but 108 were traced.

CONCLUSIONS

If it is true that there is an average duration of a number of years in the majority of cases of duodenal and gastric ulcers, many extending from twenty to thirty years, it is probable that there is an exaggerated idea of their danger to life. Acute perforation is a serious danger, which is greater when it occurs as a primary symptom of ulcer. Subacute and chronic perforations are frequently noted at operation. Extensive hemorrhage may also cause death. While few persons die from these conditions the number is greater than the number of those who succumb from surgical measures, which, if instituted in time, should restore the patient to health and activity. It is true that patients suffer, are disabled and should be relieved, and it is also probable that but a small percentage of the total number of ulcers are early recognized and treated for the true condition. Gastric ulcers may give greater discomfort than duodenal ulcers, and because of the danger of malignant degeneration should be destroyed at the time of the operation unless this procedure would add unwarranted immediate risk. I believe patients who have gastric ulcer should be informed of this danger. While blocking the pylorus has been recommended in addition to gastroenterostomy and practiced, the procedure was unnecessary and is now obsolete. In the surgical treatment of ulcer we have applied a well-known principle of agriculture: an acid and continuously wet soil is tile-drained and its surface limed.

In fact, the surgical treatment of ulcer is the best recognition of the value of medical treatment in permanently overcoming delay or obstruction and lowering the acidity with the patient's own alkalies.

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SUBPHRENIC PYOPNEUMOTHORAX—SUBPHRENIC ABSCESS *

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A SUBPHRENIC abscess is a comparatively rare condition; a subdiaphragmatic pyopneumothorax is still more unusual. The term subphrenic abscess is applied to any collection of pus situated immediately below and in contact with the diaphragm. As the liver occupies most of the space immediately below the diaphragm these abscesses are located usually between the upper convex surface of the liver and the under surface of the diaphragm. The falciform ligament divides the subphrenic space into two compartments, and forms a barrier to the spread of infection from one side to the other. The coronary ligament and its extension into the right and left lateral ligaments, forms a partition between the anterior and posterior surfaces of the liver. Collections of pus may therefore occur in five areas: (1) Right anterior; (2) left anterior; (3) right posterior; (4) left posterior, and (5) between the folds of the coronary ligament. Abscesses in all of these areas are intraperitoneal with the exception of the fifth, which is extraperitoneal. The causes of subphrenic abscess are numerous. The most frequent cause is probably appendicitis, the infection extending, usually by direct continuity of tissue, to the posterior right lateral aspect of the subdiaphragmatic space. Of almost, or quite, equal frequency are abscesses due to perforating ulcers of the stomach and duodenum, those on the lesser curvature of the stomach usually causing abscesses to the left of the falciform ligament, while perforations of the duodenum cause abscesses to the right of this fold. Other causative agencies are cholecystitis, cholangitis, abscess of the liver, diseased conditions of the colon, spleen, kidneys and pancreas, residual abscess from peritonitis, external injury, disease of the ribs or spine, empyema and pneumonia.

The abscesses sometimes contain gas, in varying amounts, which may have gained entrance from a perforated hollow viscus or may have developed from the action of gas-forming organisms.

The symptoms of subphrenic abscess are frequently obscure and the condition is, doubtless, often overlooked. The symptoms will vary somewhat with the cause and the seat of the disease. Chills, fever, and sweating are often present, while pain and tenderness with hardness and rigidity of the affected region sometimes can be elicited. At times the area of liver dulness may be increased, or it may be partially or entirely lost. An increased leucocytosis generally will be found. An X-ray

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examination should always be made, but the findings may not be conclusive or may be misinterpreted.

The treatment is incision and drainage, and this frequently involves a transpleural thoracotomy.

The object of this paper, however, is not to give an exhaustive description of this condition, but to report two cases that have occurred in my service during the current year, which presented somewhat unusual features.

CASE I. *Pyopneumothorax Subphrenicus.*—W. G., aged sixty-five years, was admitted to University Hospital on February 12, 1920. For three years he has had stomach trouble, consisting of attacks of pain and acidity, which were generally relieved by eating, or by taking bicarbonate of soda. At times he would have to take food in the middle of the night to relieve his distress.

These attacks have become more frequent, and during the past year vomiting has supervened. No blood, however, has ever been noticed in the vomitus. About ten days ago he was taken with more severe symptoms and the pains became spasmodic in character.

On admission his temperature was $101\frac{2}{5}^{\circ}$; pulse, 108; and respiration, 28. The heart sounds were clear and normal. The lungs were somewhat emphysematous. On inspection the abdomen was seen to be distended in the upper zone, below the umbilicus it was rather flat. There was rigidity and tenderness in the right upper quadrant and in the epigastrium. The liver dulness was entirely absent. The pains continued and became more severe and vomiting occurred more frequently. An analysis of his stomach contents showed free HCl, 36 per cent.; total acidity, 48 per cent.; and several analyses subsequently showed an even greater acidity. The blood-count showed red-cells, 4,900,000; leucocytes, 5600; polynuclears, 69; small lymphocytes, 30; eosinophiles, 1; haemoglobin, 85 per cent. Urea in the blood was .3 grain per 1000 c.c. The Wassermann reaction was negative. The urine contained albumin and an occasional cast, but no sugar; specific gravity, 1017.

Clinical Impression.—Gastric or duodenal ulcer, probably perforated and walled off.

Skiagraphic Report.—Small heart, displaced to left. Dome-like shadow in middle portion of right chest, arching from the mediastinum on a level with the eighth rib posteriorly upwards to middle portion of chest, then downwards to the axillary region. This shadow is about one-half cm. in thickness and corresponds in outline with the diaphragm, but it is about three inches higher than the normal position of the diaphragm. Below this shadow there is an area of increased density homogeneous in appearance, which extends to the tenth rib, and below this homogeneous shadow are areas of lesser density showing the presence of air. The upper border of the diaphragm is irregular in shape and shows the presence of several broad adhesions.

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The examination suggests an old empyema with pneumothorax in the lower right chest. Notwithstanding this report, we held to the clinical findings and acted accordingly.

Operation (February 16th).—Under nitrous oxide and ether anaesthesia an incision was made vertically through the right rectus muscle. The liver was found to be adherent around its edges to the abdominal parietes, which when separated allowed a quantity of gas to escape. This gas had a colon bacillus odor. There was but little pus, but the surface of the liver was covered with a grayish exudate. The stomach was also bound down with dense adhesions. After breaking up these adhesions a small perforation was found on the lesser curvature of the stomach, which was closed with two rows of sutures and a posterior gastroenterostomy done. Rubber tube and gauze wick drains were introduced.

Following the operation there was much drainage from the wound, moderate elevation of temperature, and acceleration of the pulse, but no vomiting or pain. He died, however, two days later, with symptoms of general sepsis.

Autopsy Report.—The liver was large and extended three finger breadths below the costal margin in the right clavicular line. All the organs on the upper side of the abdomen were matted together. The diaphragm on the right side extended to the fourth interspace, on the left to the sixth. The upper surface of the right lobe of the liver was covered with a yellowish exudate. The peritoneum was glistening and was not inflamed. An ulcer was found on the lesser curvature of the stomach, which was leaking from a small opening.

The clinical history of this case is typical of gastric or duodenal ulcer and the cutting pains suggested that a perforation had occurred, while the absence of signs of peritonitis showed that the rupture was walled off by adhesions. The chief interest in the case depends upon the complete loss of liver dulness. It is a well-known fact that many subphrenic abscesses contain gas, which may come from a perforated viscus or may be due to microbial action, but in this case the whole liver area was tympanitic on percussion. The rest of the abdomen was not unduly resonant and was collapsed rather than distended. When the abdomen was opened no free gas was found in the general peritoneal cavity, but there was a large collection of gas encapsulated between the right lobe of the liver and the diaphragm, which was due to an ulcer on the small curvature of the stomach. This fact is also noteworthy, as perforations on the lesser curvature are said by most authors to cause abscesses to the left of the falciform ligament. The low leucocyte count, 5600, is also striking. Another feature in the case was the misinterpretation of the skiagraphic findings, which suggested to the röntgenologist an encapsulated supraphrenic pneumothorax, the curved dome of the diaphragm being so far displaced upwards that it was thought to be the condensed lower margin of the lung.

SUBPHRENIC PYOPNEUMOTHORAX—SUBPHRENIC ABSCESS

CASE II. Subphrenic Abscess—Possibly From an Abscess of the Liver.—M. W., male negro, aged twenty-one years, was admitted to University Hospital June 9, 1920. The present trouble began on June 2, 1920, suddenly, with giddiness and pain in the right side under the ribs. He says he has had no cough or expectoration and that the pain was increased on deep inspiration. He is a healthy-looking person, who has never lived in the tropics or, indeed, out of Maryland.

Physical Examination.—On the right side there is decreased respiratory movement. On this side also both anteriorly and posteriorly the percussion note, from the third rib down, is markedly impaired, becoming dull near the base. The breath sounds are diminished on the right side, becoming lost at the base. There are a few râles at the left apex and the whole left side of the chest is hyper-resonant. At no time has he had chills. On admission his temperature was 102°; pulse, 110; respiration, 28. Under the impression that the case was an empyema an interne aspirated the chest and drew out pus. Having a suspicion that the case might be one of abscess of the liver, I ordered an X-ray examination to be made, which showed a rigid diaphragm with a clear picture above the diaphragm and a cloudy one below, on the right side. The left lung was quite clear. There was absolutely no pneumonia of either lung. The urinary examination showed nothing abnormal. The Wassermann reaction was negative. Cultures from the aspirated pus grew out pneumococci and streptococci. No amoebæ were found in the stools.

Operation (June 24, 1920).—Nitrous oxide gas and ether anesthesia. An incision was made over the tenth rib in the posterior axillary region, and about two inches of this bone was excised. The pleura presented and a small opening was made into it, which showed it to contain no pus. This opening was then sutured and the pleura was detached from the diaphragm. An opening was then made through the dome of the diaphragm and a large quantity of thick, almost gelatinous, pus escaped. The upper surface of the liver seemed to be rough and pitted. One rubber tube and three pieces of gauze were introduced for drainage. He did well, suffered but little, and was out of bed in a short time. Drainage was quite free and eventually a considerable discharge of bile was established. A microscopic examination of the pus failed to show hooklets, scolices or parasites, nor were any hepatic cells found.

The patient left the hospital with a sinus, but returned to the dispensary for dressings. Early in September the external wound had healed and he went home, some distance in the country. About the middle of the month he was taken ill and died in a few days. His physician thought he had a recurrence of the abscess, but no autopsy was made and the cause of death remains in doubt.

I am inclined to think that the abscess in this case was extraperitoneal; that is, situated between the layers of the coronary ligament, as the collection of pus was far back and no induration could be felt any-

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where, nor was there any material pain or discomfort after he came under my observation. Cultures from the pus showed pneumococci and streptococci, while both physical and X-ray examinations showed no evidence of pneumonia whatever.

Whether there was an abscess of the liver is problematical; the chief cause for suspecting that such might have been the case was the rather free discharge of bile subsequently and the fact that my finger detected a pitted and rough spot on the upper surface of the liver.

Lastly, the differential diagnosis between an abscess situated immediately below the dome of the diaphragm and a low encapsulated empyema is attended with many difficulties. Aspiration is useful in showing the presence of pus, but is of doubtful value in determining its exact location. A skiagraphic examination is also of value. If the pus is situated below the diaphragm the dome of this structure will be pushed up and it will be more convex than normal, while the clear lung will show above, if there is no fluid in the pleural cavity. By means of aspiration and the X-ray examination a reasonably accurate diagnosis may be made, but the exact location of the pus may await the surgeon's knife.

THE TECHNIC OF HEPATICODUODENOSTOMY, WITH SOME
NOTES ON RECONSTRUCTIVE SURGERY
OF THE BILIARY DUCTS

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THE surgery of the gall-bladder and biliary tract has been distinguished by great advances during the past few years. Of the various factors which have contributed to this development the adoption of a routine exploration of the bile-ducts and their environs as a necessary part of every operation on the gall-bladder gave the greatest impetus to progress. Such routine explorations have not only minimized the possibility of overlooking surgical conditions in the biliary tract, but have placed on record information, particularly with regard to the pancreas, which should ultimately be of great value in elucidating some of the perplexing problems still associated with this field of surgery. Experienced surgeons are only too well aware, however, that the most circumspect inspection and palpation of the gall-ducts and pancreas do not always exclude the presence of a well-concealed gall-stone, and are in accord, that, should any doubt remain that the full extent of the pathologic condition has been revealed by such exploration, instrumental exploration of the ducts from within becomes imperative. The freedom and safety with which this procedure is carried out is one of the accomplishments of modern surgery.

In marked contrast to the simplicity with which the common duct can usually be incised and explored are the difficulties which confront the surgeon when plastic or reconstructive surgery of the ducts¹ becomes necessary. The occasions for these much more serious types of operations and the various methods advocated for restoring biliary function have been presented in a number of excellent articles, notably one by Sullivan, on the use of the rubber tube; one by Walton, on his method of using the duodenal flap; and one by Eliot in which a very complete review of the subject is given. The former experiences in the Mayo Clinic were placed on record by W. J. Mayo in 1916.

The more common conditions or circumstances which may give rise to the necessity of reconstructive surgery of the bile passages may be conveniently classified as follows:

1. New growths, malignant or benign, usually occurring as duct cancer or cyst; stricture or rupture of some portion of the tract usually due to the pressure or the passage of a gall-stone.
2. Injuries to the ducts during operation, for example, stricture due to crushing or ligation; division or resection of a portion of the duct.

The number of cases of the first group is relatively few, and the technical points concerned in their management are suggested in the discussion of the second group. The second group is of unusual importance, because such injuries are by no means few⁷; because they occur most frequently during the operation of cholecystectomy, an operation which is widely and rightly recognized and adopted as the one of choice in the varied pathologic conditions in the gall-bladder; and because such injuries are avoidable.

By far the most common cause of such injuries can be attributed to the failure to identify the cystic duct. The identification of this duct in cholecystectomy is not always easy, because of the occasional difficulties in securing good exposure when the depth of the operative field, the slight mobility of a small liver, and acute or chronic inflammatory changes in and around the gall-bladder and ducts combine to embarrass the surgeon in the dissection and isolation of the cystic duct. In such cases the liver should be drawn downward and toward the median line, and separated with a spatula from the abdominal wall. A gauze compress is placed between the superior right lobe of the liver and the chest wall just behind the hepatic duct.⁹ With the liver thus held when the gall-bladder is tracted the region of the hepatic and common duct is well exposed. Occasionally it is advisable to remove the gall-bladder from without inwards, or after emptying it to split it longitudinally down to the opening of the cystic duct. As a rule, however, with the technic described by Judd, the dissection can be begun at the cystic duct with safety and certainty. Our experience in the Mayo Clinic has been that even when acute inflammation and oedema exist, cholecystectomy can be carried out without greater risk and with as good or better immediate results than accompany cholecystostomy, and the patient is spared a later operation, which so frequently is a sequence to cholecystostomy.

The second most common cause for injury arises when active hemorrhage occurs from the cystic artery, or from some anomalous branch of the hepatic artery. Blindly grasping with heavy cutting forceps into the space in which the artery has retracted has not infrequently resulted in a crushed common or hepatic duct with a later permanent stricture or fistula from ligature, scar formation, or necrosis.

The various anatomic anomalies in the biliary tract and in the related blood-vessels, which have been reviewed lately by Eisendrath^{2, 3} and Gosset,^{5, 6} and others, may finally be mentioned as a contributing cause. When the cystic duct is anomalous in its length, course, or union with the deep duct, the danger of such accidents at the hands of surgeons who are unaware or who are forgetful of the incidence of such anomalies becomes considerable.

The most common of all injuries, division or resection of a portion of the common or hepatic duct, is due, as has been pointed out, to a failure exactly to identify the cystic duct, and this in turn is often due to the

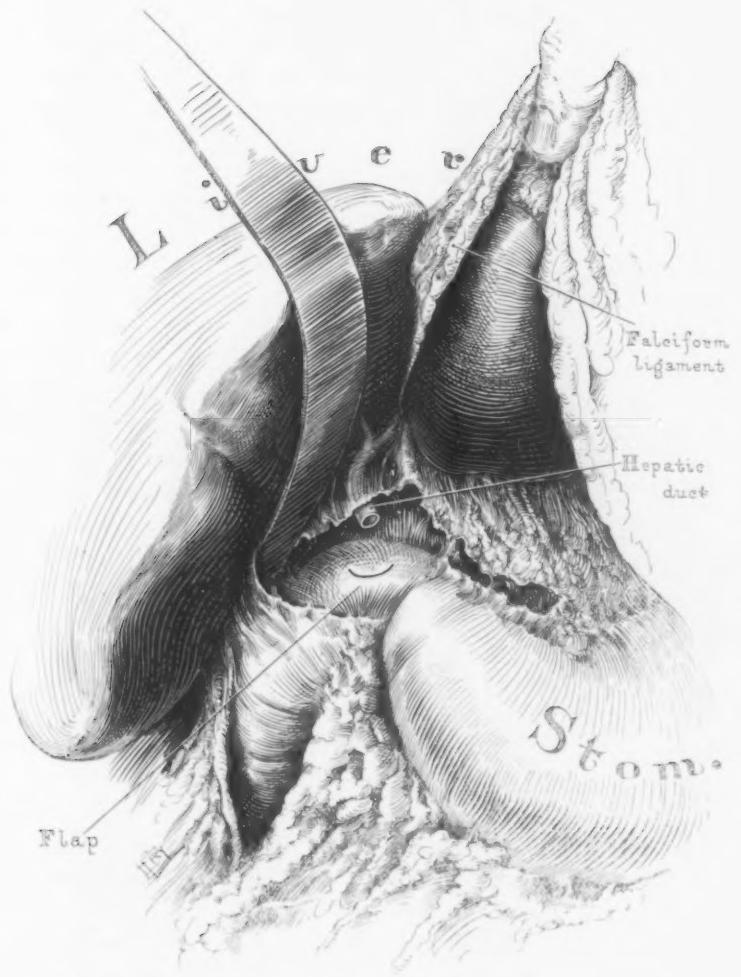


FIG. 1.—Adhesions divided and the cut end of the hepatic duct exposed.

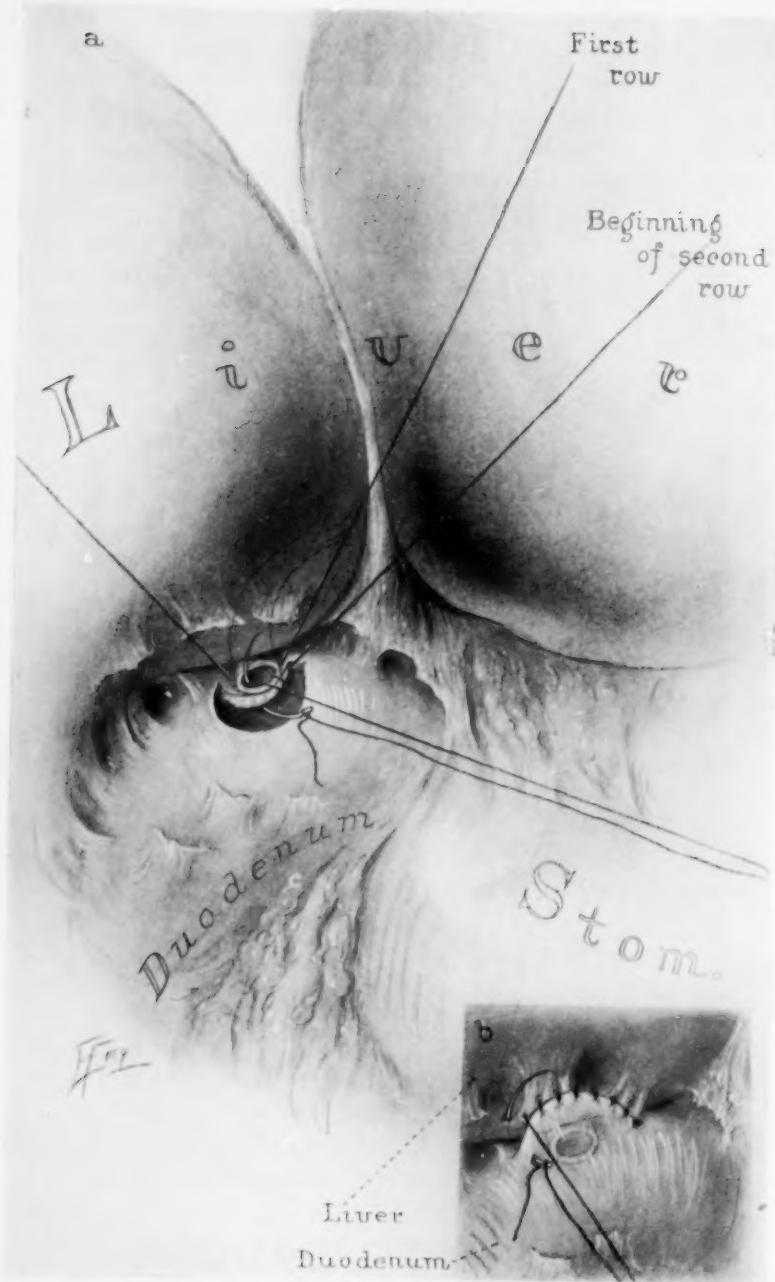


FIG. 2.—(a) All layers of the duodenal flap sutured to the entire thickness of the hepatic duct two-thirds of the way around posteriorly to secure a muco-mucous union posteriorly and laterally. (b) The free anterior margin of the opening of the duodenum is sutured to the surface of the liver above, leaving a large interval between the duodenal mucosa and duct so as to allow for contraction.

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anomalies just mentioned. Few surgeons of wide experience have not accidentally committed such an error. I recall very vividly the first time these abnormalities and their dangers were brought to my attention. I was performing a cholecystectomy under the most favorable conditions; in placing a curved clamp on the cystic duct below a small stone impacted in its lower portion, a loop of the hepatic duct about 2 cm. in length was engaged, and resected when the cystic duct was severed. It is generally true, fortunately, that the results of such an accident, if recognized at the time, can be remedied. In this case I employed a T-tube to aid in the anastomosis. Interrupted catgut sutures were first carefully placed in the tissues posterior to the duct to lessen, as much as possible, tension on the suture line in the duct; then the cut ends were sutured posteriorly; the tube was put in position and finally the union completed laterally and anteriorly. The tube was removed in three weeks and a perfect functional result has been maintained for more than five years. The anastomosis can also be made over a small straight tube, or, when the duct is large, without the use of a tube. The point to be emphasized is the importance of realizing that an injury has occurred and of repairing the damage immediately; otherwise the patient is left in a most unfortunate condition, for, if he survives the operation a very serious second operation must be performed, either to relieve duct obstruction due to ligation or stricture, or to close a persistent biliary fistula.

A considerable number of cases has been observed in the Clinic in which the injury was either not recognized or the damage not properly repaired at the time the accident occurred. These cases tax the abilities of the skilled surgeon to the utmost. In some the injury has been such as to permit reconstruction by the method which I just described, or by one of the many ingenious methods which have been described by others. On the other hand, the damage may have been so extensive or of such a character as to necessitate the implantation of the hepatic duct into the duodenum. This operation has given better immediate and late results than other methods employed in the Clinic, and we look on it as the operation of choice in the average case of this type. Even in the most hazardous cases in which jaundice has existed for some time, with the resultant serious changes in the liver, the blood-vessels, and the blood, the permanent reestablishment of biliary function by direct union of the hepatic duct and the duodenum can be accomplished with reasonably low mortality.

The method of hepaticoduodenostomy evolved by W. J. Mayo has certain obvious advantages over previous methods and offers, I believe, the best chance of success, when its details are scrupulously carried out.^{10, 11 *}

* W. J. Mayo reported in 1905 one of the earliest successful cases of hepaticoduodenostomy. The patient fifteen years later is alive and well; she has had several children since, and, although she has gone through severe illnesses, she has never had the slightest obstruction or infection of the liver ducts.

An incision is made in the epigastrium slightly to the right of the midline, beginning at the sternal notch, and continuing downward for a distance sufficient to permit ample exposure. Through the upper end of this incision, avoiding in this way the adhesions in the former field of operation, an attempt is made to dissect directly down on the common duct (or its site, if it has been resected). The duodenum should first be located and is usually found in the mass of adhesions which have developed around the stump of the hepatic duct. Fortunately it is not necessary to locate the distal end of the common duct. The stump of the hepatic duct may be exceedingly difficult to find, especially if no fistula exists, and in debilitated patients many anxious moments may be spent in searching for it. The most careful dissection is necessary in those cases in which a piece of the common duct has been removed, because of the tendency of the portal vein to bulge into the space formerly occupied by the duct. Before any doubtful channel is opened the use of a fine aspirating needle with a glass-barrel syringe is, of course, advisable. Experience has shown that the stump of the hepatic duct lies, as a rule, flush with the liver, and that if dissection is carried down the liver notch from which the gall-bladder has been removed, a mass of fixed tissue, containing the remnants of the right free margin of the gastrohepatic omentum, will be found, which, when dissected from the liver, will disclose the duct. The stump of the hepatic duct is freed as much as possible from its adhesions, but it is rarely possible to secure a projection beyond the liver fissure for more than 0.3 cm. to 0.5 cm. The duodenum, as has been noted, is usually drawn into the same mass of adhesions and it is always wise to avoid separating it posteriorly. If it is separated, a few catgut stitches will draw it up again to the stump of the duct. A slightly curved flap is then dissected out of the entire thickness of the duodenal wall over an area which will leave an opening into the duodenum about 2 cm. in diameter (Fig. 1). The duodenal flap is then approximated to the posterior and lateral aspects of the stump of the hepatic duct in such a manner as to permit of a mucous union of the posterior half of the circumference of the duct, with the edge of the flap sutured as shown in Fig. 2. The opening in the duodenum is, of course, much larger than the hepatic duct. The remaining free margins of the opening in the duodenum are sutured to the capsule of the liver just above the hepatic duct end by continuous catgut suture so that the under surface of the right lobe of the liver, or more correctly Glisson's capsule and the scar tissue adherent to it, effectually closes the opening in the duodenum not occupied by the end of the hepatic duct. A considerably wider area of the duodenum is then drawn up toward the liver and fixed with catgut sutures. The omentum is caught by the tip and divided if necessary so that it may be used effectually to surround the anastomosed area. Drainage is seldom necessary; if needed two small strips of rubber tissue are introduced, one above and one below the anastomosis. In some cases

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a moderate amount of bile may escape for a few days. This has always ceased within a week, however, and healing finally has been complete in each case. In no case has there been any evidence of subsequent obstruction to the duodenum, and in no case a failure to deliver bile into the duodenum.

It will be noted that this technic provides a large opening in the duodenum and a mucous union for two-thirds or at least one-half the circumference of the hepatic duct stump. These provisions, together with the method of suturing the opening in the duodenum to the liver, allow for contraction and obviate the danger of secondary stricture, so that obstruction does not take place. In a considerable percentage of cases in which we have attempted direct union by making the opening in the duodenum the size of the opening in the hepatic duct obstruction followed and the operation had to be done over. This, apparently, has been the experience of others.

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AN ANALYTICAL STUDY OF FIFTY CASES OF URETERAL STRICTURE AND PYELITIS*

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THE object of this study is to point out:

First, the more common pitfalls which are likely to beset the surgeon when confronted by lesions within the abdominal cavity;

Secondly, to forcibly direct attention to the frequent and close relationship existing between lesions of the kidney and ureter and remote foci of infection.

So constant has been this association in the study of the cases forming the basis of this report that one is almost driven to the conclusion that they stand in the relation of cause and effect.

Pathologic lesions within the renal pelvis and of the ureter undoubtedly occur with greater frequency in the female than in the male, and more often on the right side than on the left. Just why this should be has not, as yet, been fully and satisfactorily explained.

Keyes, in his admirable article "Infections of the Kidney," contributed to "Cabot's Urology," views with favor the theory advanced by Volkow and Delitzen that the shallowness of the lumbar recess in women as compared with men, and on the right side as compared with the left, is competent to explain the preponderance of both right-sided renal mobility and infection. Still another unquestioned mechanical factor is the more frequent occurrence in the female of a movable cæcum and ascending colon, which, by dragging upon the kidney, materially interferes with both renal circulation and drainage.

These theories, however, do not explain the very frequent bilateral involvement often seen in the more chronic forms.

The frequency with which one encounters obstructive lesions in the ureter, and the satisfactory results obtained from appropriate treatment and the establishment of adequate drainage, justify the conclusion that strictured conditions of the ureter may likewise be potent factors in the production and perpetuation of these infections whether unilateral or bilateral. Certain it is that the "mechanics" of renal infection should never be lost sight of. Any physical factor which, by its presence, tends to impair the normal functioning of the kidney, whether it be of circulation or drainage, should be taken into serious account and remedied if possible.

In the series now under consideration, all were in females, as the writer's cystoscopic work is confined exclusively to this sex.

* Read before the Southern Surgical Association, December 14, 1920.

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Of the fifty cases, thirty-nine, or 78 per cent., were unilateral; twenty-six, or 52 per cent., occurring on the right side, and thirteen, or 26 per cent., occurring on the left. Eleven of the fifty, or 22 per cent., were bilateral. It will thus be seen that the ratio of incidence of the right-sided lesion as compared with the left is as 2 to 1, and that of bilateral to unilateral incidence is as 1 to 4.5, approximately.

It is the right-sided lesion that furnishes the ready trap for the hasty and impulsive surgeon. If the patient be experiencing an acute attack in which the strictured area becomes inflamed and swollen, with the damming up of infectious products within the kidney pelvis, thereby producing exquisite pain, considerable temperature and a pronounced leucocytosis, the appendix will almost certainly be bottled within twelve to twenty-four hours. The mimicry here displayed is such as to mislead the most astute, unless one be eternally on his guard.

In this series, seven, or 14 per cent., had been subjected to this unnecessary ordeal; two of the seven being mistakes committed by the writer himself.

Points of importance in differentiating between these two lesions are the following:

- (a) Careful microscopical examination of a catheterized specimen of urine.
- (b) Absence of marked right-sided abdominal rigidity when the lesion is retroperitoneal. The acutely inflamed appendix rarely fails to produce demonstrable rigidity in the lower right quadrant.
- (c) Hyperpyrexia points to infection within the kidney pelvis; rarely to the appendix.
- (d) The Murphy sequence of onset of symptoms when the lesion is appendiceal; that is, pain, nausea, vomiting, elevation of temperature.

In the more chronic forms of this affection, where the patient's suffering has been allowed to drag through a period of months or years, the honors of surgical immolation are divided between the appendix, on the one hand, and the reproductive organs, on the other.

Of this series, eleven, or 22 per cent., had been operated for "chronic appendicitis" alone (exclusive of the seven, or 14 per cent., operated for "acute appendicitis"). In six, or 12 per cent., the diagnosis of "chronic appendicitis" had been made and operation advised. In nine, or 18 per cent., the primary surgical assault had been made on the reproductive organs alone. In three, or 6 per cent., two or more operations had been performed in the effort to eradicate the cause.

All told, therefore, twenty-seven, or 54 per cent., had either been operated upon or had had operation advised as the necessary remedial measure.

These figures tally closely with the experiences of other men whose statistical material is larger. Braash, of the Mayo Clinic, states that at least 50 per cent. of all the right-sided renal and ureteral lesions applying to this clinic for relief have previously been subjected to one or more futile

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operations. Hunner, of Baltimore, in his experience, finds the percentage even higher. These figures bespeak a too high percentage of error on the part of the general surgeon, and present an appealing argument for the more frequent use of those agencies which have placed the diagnosis of lesions of the urinary tract within the realm of an exact science.

The second important fact revealed by this study is the consistent occurrence of one or more foci of infection somewhere within the body.

The puzzling feature of most of the experimental and scientific work done in the realm of urinary infections has been to harmonize the constant and dominating presence of the colon bacillus in these urines with the types of organisms controlling the field in the organ or organs suspected of being the originators of the mischief. Why, if a streptococci laden tonsil be the *fons et origo* of this type of renal pathology, cannot we oftener demonstrate streptococci in the urine?

With the work of Rosenow upon the elective localization of streptococci we are all familiar. Yet he, after injecting 220 different strains of streptococci into 883 animals, found lodgment in the kidney in only 9 per cent. One of the most convincing pieces of work, bearing immediately upon focal infection and pyelonephritis, has just been completed by Bumpus and Meisser, of the Mayo Clinic. Their studies were based upon a series of cases presenting subacute lesions of the urinary tract with dental or tonsillar sepsis, and colon bacilli predominating in the urine. Not only were they able to produce in the majority of the animals injected definite renal lesions from cultures taken from the teeth or tonsils, but in two of their cases, showing marked exacerbation following tooth extraction, they were able to recover streptococci from the urine, which, when injected into animals, produced lesions of the urinary tract identical with those obtained from cultures of the teeth.

These experiments show conclusively that streptococci isolated from infected tonsils and teeth manifest a striking selective affinity for the urinary tract; for, of twenty-six animals injected with the primary cultures, twenty-four had lesions of the kidney and eight showed lesions in both kidney and bladder.

Further, they were unable in those patients whose urine showed only colon bacilli to produce in animals any definite renal lesions by intravenous injection of cultures from this source.

The ureters, in some instances, also showed definite hemorrhagic lesions, their walls being both inflamed and thickened.

In the series now under consideration the tonsil must be awarded first place; as in twenty-one, or 42 per cent., this organ manifested, both by its appearance and behavior, unmistakable evidence of disease. In the majority of cases there was a definite history, not of one, but of many attacks of acute tonsillitis, and the tonsil was not considered blamable until judgment had been passed by a competent throat specialist.

Next in importance come the teeth; eleven, or 22 per cent., revealed

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definite evidence of one or more—sometimes several—apical abscesses. No conclusions were drawn concerning the mouth without the corroborative evidence of the X-ray.

In seven, or 14 per cent., both tonsils and teeth presented definite evidence of disease, and in the tabulated report accompanying this paper the honors have been equally distributed between these organs.

In two, or 4 per cent., sinus infection—one frontal and one antrum—was the apparent source from which the urinary lesion sprang.

In only nine, or 18 per cent., was evidence lacking of a definite focus which readily might be held responsible, and these have been classed as "uncertain." Even this small percentage could likely have been reduced had the same degree of care been exercised in a search, in the earlier cases, for the probable focus of infection as was done in the later cases.

The average number of years which the trouble had persisted was eight and one-quarter; the shortest being one year, the longest twenty-five. One sees at once that chronicity, due largely to a failure to grasp the underlying pathology, is an outspoken characteristic of these lesions. When diligence is observed in recording the history, the beginning of the kidney lesion is often to be found faithfully reflected in one or more attacks of tonsillitis in childhood, complicated by a continued but irregular fever, back or loin pain, and bladder disturbances. The age of adolescence and young womanhood confers, seemingly, a period of greater or less immunity, but quite certainly to be lighted up later during the child-bearing age. The common picture of pyelitis of pregnancy does not originate *de novo*. The insult added to an already crippled drainage system by the changed mechanics of the pelvis brought about by the gravid uterus is quite sufficient to light up the smoldering flames, provided the primary focus be still present.

In 30, or 60 per cent., either pus was found in the urine at the time of renal catheterization or the history pointed to one or more definite attacks of pyelitis. The story unfolded by many of these cases as to the character, location and the behavior of their pain is as straightforward and as valuable, diagnostically, as is that of the duodenal ulcer or of the crippled appendix. The cases of considerable duration and with a definite history of antecedent pyelitis usually showed pus from the affected side at the time of ureteral catheterization. Those of shorter duration and with a negative pyelitis history, even though manifesting definite ureteral strictures, frequently gave negative urines and culture.

Culturally, the colon bacillus was found in twenty-three, or 46 per cent.; the staphylococcus albus in three, or 6 per cent.; and in twenty-four, or 48 per cent., no growth was obtained. The appearance of the staphylococcus albus in three cases was, in all probability, due to accidental contamination at the time of collecting the urine, as this organism is short-lived and plays a very minor rôle in infections of the renal pelvis. In no instance was the streptococcus recovered; due, possibly, to the fact that

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TABLE I

Number	Age	Sex	Side involved	Bilateral	Number years existing	Probable focus	Pus found in urine or definite history of pyelitis	Location of stricture above bladder	Organism found on culture	Previous operations performed for relief
1 35	35	F	.....	Yes	5	Tonsils	Yes	4 and 5 cm.	Colon	None.
2 53	53	F	.....	Yes	15	Teeth	Yes	10 and 12 cm.	R. colon, L. colon	Appendectomy recommended.
3 20	20	F	Right	.....	2	Tonsils	Yes	3 cm.	None	Appendectomy.
4 41	41	F	Left	.....	22	Tonsils	Yes	9 cm.	Colon	Uterine suspension.
5 37	37	F	Right	.....	12	Tonsils	No	3 cm.	None	Curetttement.
6 36	36	F	Right	.....	15	Tonsils	Yes	12 cm.	Colon	Amp. cervix and repair perineum.
7 20	20	F	Right	.....	3	Tonsils	No	3 cm.	None	Operation for appendectomy recommended.
8 37	37	F	Right	.....	10	Uncertain	No	15 cm.	Staph. alb.	None.
9 38	38	F	Right	.....	15	Teeth	No	10 cm.	None	Appendectomy recommended.
10 38	38	F	Left	.....	3	Sinusitis antrum	No	5 cm.	None	None.
11 33	33	F	Right	.....	9	Uncertain	Yes	15 cm.	None	Appendectomy.
12 18	18	F	Right	.....	2	Prob. tonsils	No	3 cm.	None	Appendectomy.
13 34	34	F	Right	.....	14	Tonsils and teeth	No	7 cm.	None	Appendectomy and kidney anchored.
14 23	23	F	Left	.....	3	Tonsils	No	3 cm.	None	Appendectomy and ovariotomy.
15 40	40	F	Right	.....	12	Prob. teeth	Yes	8 cm.	Colon	None.
16 46	46	F	Left	.....	5	Teeth	Yes	3 cm.	Colon	None.
17 34	34	F	Left	.....	3	Teeth	Yes	3 cm.	Staph. alb.	None.
18 33	33	F	Right	.....	14	Uncertain	Yes	3 cm.	Colon	None.
19 35	35	F	Right	.....	10	Teeth and tonsils	Yes	4 cm.	Colon	None.
20 20	20	F	Right	.....	2	Tonsils	No	4 cm.	None	None.
21 43	43	F	Left	.....	10	Teeth	Yes	11 cm.	Staph. alb.	Curetttement.
22 32	32	F	Right	.....	10	Tonsils	Yes	4 cm.	None	None.
23 18	18	F	Right	.....	4	Tonsils	No	13 cm.	None	Appendectomy.
24 42	42	F	.....	Yes	15	Teeth	Yes	R. 3 cm., L. 3 cm.	R. colon, L. colon	Appendectomy.
25 41	41	F	Right	.....	10	Teeth and tonsils	No	5 cm.	None	None.
26 24	24	F	.....	Yes	4	Tonsils	Yes	R. 5 cm., L. 3 cm.	L. none	Appendectomy.
27 44	44	F	Right	.....	12	Teeth and tonsils	Yes	5 cm.	Colon	Appendectomy.
28 22	22	F	Right	.....	4	Tonsils	No	5 cm.	None	Appendectomy.
29 24	24	F	Right	.....	1	Tonsils	No	4 cm.	None	None.
30 28	28	F	.....	Yes	8	Uncertain	Yes	R. 3 cm., L. 8 cm.	Colon	Appendectomy.
31 32	32	F	Right	.....	11	Teeth	Yes	3 cm.	Colon	None.
32 26	26	F	Left	.....	17	Tonsils	Yes	3 cm.	None	Appendectomy ovariotomy.
33 35	35	F	Right	.....	6	Tonsils	No	12 cm.	None	None.
34 53	53	F	.....	Yes	25	Uncertain	L. pus R. none	R. 7 cm., L. 4 cm.	R. colon, L. colon	Curetttement.
35 32	32	F	.....	Yes	12	Teeth	R. pus	R. 4 cm., L. 3 cm.	R. colon, L. colon	None.
36 19	19	F	Right	.....	6	Tonsils	Yes	3 cm.	Negative	Appendectomy advised.
37 30	30	F	Right	.....	10	Tonsils and teeth	Yes	4 cm.	Colon	Appendectomy.
38 60	60	F	.....	Yes	15	Tonsils	Yes	R. 3 cm., L. 3 cm.	R. colon, L. neg.	Appendectomy, bilat. ovariotomy, hysterectomy.
39 27	27	F	Left	.....	8	Prob. teeth	Yes	12 cm.	Colon	None.
40 49	49	F	Left	.....	3	Teeth	Yes	4 cm.	Colon	None.
41 52	52	F	Left	.....	20	Teeth	Yes	4 cm.	Colon	Right nephrectomy.
42 33	33	F	Right	.....	11	Frontal sinus	Yes	3 cm.	Colon	Double ovariotomy and appendectomy.
43 32	32	F	Right	.....	7	Prob. teeth	No	4 cm.	None	Appendectomy.
44 18	18	F	Left	.....	1	Tonsils	No	3 cm.	Colon	None.
45 24	24	F	Right	.....	9	Tonsils and teeth	Yes	R. 4 cm., L. 11 cm.	Colon	Appendectomy and right ovariotomy.
46 32	32	F	.....	Yes	5	Tonsils	No	R. 4 cm., L. 4 cm.	None	Appendectomy, Susp. of uterus.
47 23	23	F	Left	.....	16	Tonsils	No	3 cm.	None	None.
48 13	13	F	.....	Yes	4	Tonsils	Yes	None	Colon	None.
49 35	35	F	.....	Yes	12	Tonsils	No	R. 6 cm., L. 13 cm.	None	(a) Appendectomy. (b) Doub. ovariot.
50 38	38	F	Left	.....	4	Teeth	No	3 cm.	None	None.

URETERAL STRICTURE AND PYELITIS

no cultures were made in any of the pyelitis cases during an exacerbation.

Finally, in forty-nine, or 98 per cent., an appreciable obstruction could be demonstrated at some point within the ureter above its entrance into the bladder, by means of the wax bulb implanted upon the catheter.

In thirty-five, or 70 per cent., the obstruction was from 3 cm. to 6 cm. above the bladder opening or within the broad ligament area. In fourteen, or 28 per cent., the obstruction occurred from 9 to 12 cm. at or near the pelvic brim.

The only case in the series failing to reveal ureteral obstruction was that of a child of thirteen, with bilateral pyelitis.

CONCLUSIONS

1. The frequent occurrence of symptom-producing lesions of the urinary tract in the female demands an exact diagnostic study before resorting to surgery.
2. These lesions are largely dependent upon infections of an haemogenous origin, the primary foci of which must be diligently sought out and removed before permanency of cure can be hoped for.
3. Both clinical experience and experimental studies tend to incriminate tonsils and teeth as the chief offenders.
4. Not only are strictured conditions of the ureter of more frequent occurrence than has been generally supposed, but their presence, by mechanically impeding drainage, constitutes an important factor which must be reckoned with in the effort to clear away subacute or chronic infections of the urinary tract.

EXSTROPHY OF THE URINARY BLADDER WITH CARCINOMA*

BY WILLIAM E. LOWER, M.D.
OF CLEVELAND, OHIO

THE rare occurrence of a carcinoma in an exstrophy of the bladder and the ingenious device which rendered the patient fairly comfortable but nevertheless proved a menace, as it was probably the prime causative factor of the carcinoma, prompts the report of the following case history.

The patient, a man aged fifty years, presented himself for relief from ureteral obstruction on the right side. He had a congenital defect of the penis and bladder constituting complete epispadias and ectopia vesicæ. For this condition he had worn a metal urine collector of his own device (Figs. 1 and 2). As a result of the obstruction of the right ureter he suffered greatly from pain in the right kidney region. Examination showed a large red bleeding mass the size of a large hen's egg protruding from the abdominal wall in the region of the symphysis pubis (Fig. 3). This mass occupied the site of a congenital opening into the bladder into which the two ureters emptied. The open bladder communicated by an open channel with the dorsum of the penis, which was deficient. The urethra was lying open along the dorsum of the penis and gave it the appearance of having been laid open by a longitudinal incision from the base to the glans. The testicles and scrotum appeared normal.

The bladder was excised by a two-stage operation. At the first operation the right ureter was transplanted into the rectum; at the second, the left ureter was also transplanted into the rectum and the bladder excised. These operations were performed on the 5th and 23rd of March, respectively. The defect in the abdominal wall was filled in by a fascia lata transplant. On May 28th the man reported in splendid general condition. He had gained about twenty pounds in weight and was doing work on his farm. Most significant of all, he had complete urinary control, and could retain urine from ten at night until seven in the morning (Fig. 4).

This case presents one significant fact—that the carcinoma occurred in an exstrophy. During the later years, the patient's comparative comfort was principally due to a device of his own invention for catching the urine. This very ingenuity, however, probably caused the carcinoma, which undoubtedly was due to irritation from this metal collector. As for the operation itself, the transplantation of the ureters into the rectum has made it possible to offer to such unfortunate cases as this much more assured promise of relief than was possible by former methods.

* Reported before the Ohio State Medical Association, June 1, 1920.

EXSTROPHY OF THE BLADDER WITH CARCINOMA



FIG. 1.—Metal urine collector devised by patient.



FIG. 2.—Metal urine collector shown in Fig. 1, as worn by patient.



FIG. 3.—Carcinomatous growth caused by friction of urine collector.



FIG. 4.—Post-operative results two months after operation.

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At just how early an age the transplantation of the ureters can be successfully accomplished is still undecided. To transplant them in infancy means that the child will not only be constantly wet but badly soiled as well. Until the child has reached an age when he will control the anal sphincter, nothing will be gained by transplantation. When anal control is attained, however, transplantation of the ureters to the large intestine provides the utmost relief to the patient. This is true not only of cases of exstrophy of the bladder, but this method provides the greatest comfort also in certain cases of inoperable carcinoma of the bladder not accompanied by exstrophy. In these latter cases a suprapubic opening does not give the desired result, as it does not divert the urine from the raw surfaces.

Transplantation into the groin or into the loin requires the adjustment of a well-fitting retainer which at best is more or less of a nuisance. Transplantation into the large intestine offers the best result from the standpoint of the patient's comfort.

OPERATIVE TREATMENT OF GONORRHŒAL EPIDIDYMITIS

BY CHARLES S. VIVIAN, M.D.

OF PHOENIX, ARIZONA

SINCE 1918, when attention was called to the operative treatment of gonorrhœal epididymitis by the author in an article published in the *ANNALS OF SURGERY*, numerous operators have published accounts of their experience with the operation as described at the time, or with procedures which differ from it in minor detail.

The author has operated upon approximately one hundred cases of epididymitis by this modification of the Hanger operation since the original contribution was published.

The reports in the literature, together with the author's experience, have served to emphasize the conclusions reached in the paper of 1918, with the exception that operation is now believed to be the best method of treating gonorrhœal epididymitis in any stage.

Two clinical observations, with their theoretical interpretations, served as the basis upon which the operation was first undertaken.

1. That in medically treated epididymitis, the meatal discharge stops with the onset of the swelling of the epididymis.
2. That when the swelling of the epididymis begins to subside, the meatal discharge returns.

It remains only necessary to hypothecate that the swelling of the epididymis, by occluding the radicles of the vas deferens, prevents meatal discharge; and, that reëstablishment of drainage through the vas deferens is brought about by subsidence of the occlusive swelling in the epididymis.

It is only necessary to see one acutely inflamed epididymis turned out of the scrotum at operation to realize the anatomical basis of this hypothesis, for it is quite apparent that the tightly stretched tunica closely binding the epididymis to the testicle, and squeezing the beginning of the vas in its embrace, will not permit drainage from the inflamed part. The fact that, in every instance, except the very chronic cases, the meatal discharge returns after operation which aims to relieve the pressure by releasing the tunica and puncturing the vas, proves the hypothesis.

The operation which has been found to insure the utmost relief of pressure and to return the patient to active life in the shortest time, is conducted through the widely incised skin of the scrotum. A general anæsthetic is advisable because the pain of the average acute epididymitis is such that local infiltration anæsthesia is inadequate. However, combined local and nitrous oxide anæsthesia gives very satisfactory results in the acute cases and is ideal for the old chronic ones, where the operative treatment may be combined with vasopuncture.

The skin is opened in an anterior scrotal line, and is separated by blunt dissection from the underlying tunicae in order to partially turn out the testicle and to facilitate the recognition of the tunica albuginea.

In the normal testicle dissected at the post-mortem table, the recognition of the proper tunica for excision and suture is easy, but the diseased scrotal contents densely adherent by inflammatory exudate, or scar tissue, make a much more difficult problem. It is of utmost importance that the covering of the testicle should not be opened, because of the danger of infecting the tubules or furnishing an hernial exit for them. If covering is accidentally opened, it should be immediately closed with catgut before proceeding. In the majority of cases, however, there is an accumulation of fluid under the tunica which, when tapped by the incising scalpel, gives a key to the proper layer to be removed.

This fluid is variable in its amount and character; it is usually of considerable amount and of the typical hydrocele color and consistency. There may, however, in the more acute cases, be only a few drops of sero-sanguinous fluid or frank pus. All of these fluids, on culture, will grow gonococci, thus furnishing adequate reason to prevent their retention or reformation in the scrotum.

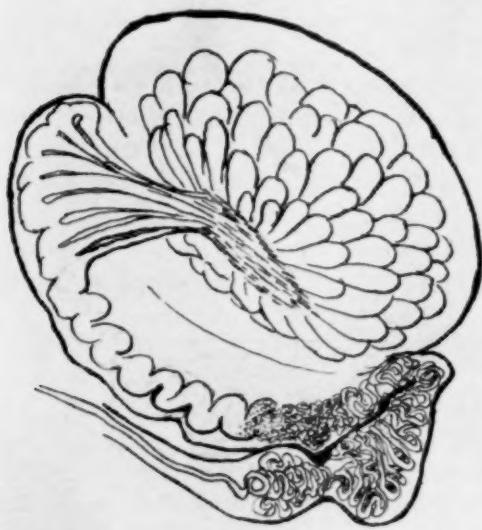


FIG. 2.—Showing how pressure of inflammatory swelling in the epididymis may occlude the radicles of the vas deferens.

Having, then, identified the proper tunica, it is dissected free from the epididymis by sharp dissection; badly diseased and torn portions are excised, and that which remains is turned back and sutured loosely behind the cord with catgut, thus preventing a recurrence of the hydrocele. Before suturing the tunica, it is well to do vasopuncture if it is intended to combine the two procedures.

Having protected the structures of the cord by suturing the tunica over them, the next step is to relieve the inflammatory pressure in the epididymis itself. A few very superficial incisions are made in the epididymis with a scalpel, and through one of these a dull probe is introduced, pushing aside the tubules, but not perforating them. Frequently, small collections of pus are evacuated from pockets among the interstices of the tubules. The probe is made to explore the entire extent of the epididymis, and a drain of folded rubber tissue is now introduced into



FIG. 1.—Radicles of the vas deferens occluded by swollen epididymitis.



OPERATIVE TREATMENT OF GONORRHEAL EPIDIDYMITIS

the epididymis and caught in place by means of a catgut suture; through it, and the covering of the epididymis, the testicle is returned to the scrotum, the drain being led out at the lower angle of the incision and the skin is closed with silkworm-gut sutures.

The relief from pain in the acute cases is immediate. The temperature drops to normal in twenty-four to thirty-six hours, and by the time the drain is taken out upon the fourth or fifth day, the epididymis is much reduced in size. The drainage of purulent material frequently follows removal of the drain for a week, or even two weeks, but this does not prevent the patient from being up and about in one week, and being at work in another.

The course of the accompanying urethritis is favorably influenced by the operation of epididyotomy in the more chronic cases, and frequently the operative treatment of the epididymi, together with bilateral vasopuncture, will usually clear up the persistent mournful morning drop of a year's standing or more. In several cases of treatment by bilateral epididyotomy, the author has secured specimens of the semen and found them to contain living spermatozoa.

It is safe, then, to conclude that epididymitis may occur on the unoperated side, but it has never been known to recur in the side upon which the operation of epididyotomy has been done. It is then safe to conclude that epididyotomy is the method of choice in treating any type or stage of epididymitis; that inflammatory swelling of the epididymis prevents meatal discharge, and that speedy relief from pain, and return to normal, follow operation.

COMPRESSION FRACTURE OF THE FIRST LUMBAR VERTEBRA WITH DELAYED SYMPTOMS (KUEMMEL'S DISEASE)

BY RUDOLPH V. GORSCH, M.D.
OF NEW YORK CITY

THE following case history is presented not only to add to the number of cases already reported, but also to emphasize the difficulty and importance of early diagnosis in spinal injuries and especially compression fracture of the vertebral bodies.

CASE I.—W. L., male, aged fifty-six years. Three months before coming under my care the patient sustained an injury to his back, having been thrown from a derailed freight car. He was taken to a local hospital where his surgical attendants informed him that no bones were broken in his back. Röntgenograms were taken but apparently revealed no fracture. He was under treatment at the hospital for six weeks complaining chiefly of moderate pains in his back, but was finally discharged as cured.

Two months later, however, the pains recurred in a severer form and were accompanied by numbness along the lower border of the ribs. He also noticed at this time a "hump," as he called it, at the site of his old injury.

A month later he came under my care and the following physical findings were noted: In the lumbar region of the spine there is a distinct kyphos. The vertebral spines are made out with difficulty. Motion is distinctly limited and on deep pressure there is moderate tenderness over this area. A röntgenogram reveals an old crushing fracture of the first lumbar vertebral body.

Comment.—One is impressed in reading over the cases reported with the failure to make an early diagnosis even with the aid of röntgenograms. The main reason for this is the lack of marked persistent sensory or motor symptoms referable to cord injury, the condition being lightly passed over as a "back sprain," arthritis, contusion or something else. The patient is not "sick enough" to have fractured a vertebra.

Furthermore, there are none of the usual signs of fracture present. The X-rays offer the only positive means of making an early diagnosis, and their frequent failure is not so readily accounted for. Probably, as in fracture of the skull, there are conflicting shadows or, as Baker sets forth * in a recent article, there is no early röntgenographic evidence of a bony lesion.

* R. H. Baker: Compression Fracture of Vertebral Bodies with Delayed Symptoms. Report of Seven Cases. (Kuemmel's Disease.) *Surgery, Gynecology and Obstetrics*, October, 1920, vol. No. 31, No. 4, p. 359.

COMPRESSION FRACTURE OF LUMBAR VERTEBRA

The late diagnosis made two months to two years following the original injury is comparatively easy. The diagnostic points are: A definite history of spinal injury, a distinct kyphos at the site of trauma with limitation of motion, muscular spasms, tenderness over the affected vertebra, and pains of varying intensity radiating to either side along the



FIG. 1.—Radiograph three months following injury. Note the wedge-shaped outline of first lumbar vertebra opposite arrow.

course of the respective nerves. Finally, there is a distinctive röntgenogram of which the accompanying is typical.

It would seem advisable in all cases of spinal injuries where the diagnosis is in doubt to give a guarded prognosis and to treat the case as one of fracture by efficient and rather prolonged fixation, which would undoubtedly prevent much of the subsequent pain and deformity.

RÖNTGENOGRAPHIC STUDIES OF BRONCHIECTASIS AND LUNG ABSCCESS AFTER DIRECT INJECTION OF BISMUTH MIXTURE THROUGH THE BRONCHOSCOPE*

BY HENRY L. LYNAH, M.D.

AND

WILLIAM H. STEWART, M.D.

OF NEW YORK, N. Y.

DOCTOR STEWART's first experience in outlining the bronchial tree with bismuth mixture was purely accidental. In October, 1915, while fluoroscoping an old man with an œsophageal obstruction, he observed some of the bismuth paste passing from the œsophagus directly into the trachea through a fistulous opening, a portion of the paste passing down into the lower bronchi. A röntgenogram was immediately taken. The patient had three or four coughing spells, bringing up particles of bismuth paste and the following day he seemed none the worse for his experience. The examination was repeated about a week later with no ill effects.

Upon investigation Doctor Stewart found that a number of similar cases had been reported. It occurred to him at that time, that, with proper precautions, the injection of opaque substances into the lung through the bronchoscope, could be safely undertaken.

It was evident that advancement along this line was slowly being made, for in 1917 Dr. Sidney Yankauer treated a case of bronchiectasis by direct applications of iodine solution to the diseased area through the bronchoscope. In conjunction with Dr. Willy Meyer and Doctor Yankauer, this patient was carefully watched röntgenographically. Complete recovery occurred.

Between 1915 and 1920 two cases of tracheo-œsophageal fistula came under observation in which the main bronchial tree on both sides was outlined by bismuth paste escaping from the œsophagus through a fistula into the trachea. In early 1920, the same phenomena occurred in a case of carcinoma of the œsophagus, located just above the arch, complicated by laryngeal paralysis; also, in a patient suffering from carcinoma involving the laryngopharynx. In both these cases the bismuth paste entered the trachea beneath the epiglottis which was imperfectly closed. Repeated Röntgen examination of these two patients did not cause any ill effects.

During Doctor Stewart's army experience at Biltmore, N. C., while examining patients suffering from chronic empyema, he frequently injected bismuth mixtures into an empyemic cavity which had direct communication through a pleuro-pulmonary fistula with a branch bronchus.

* Read before the American Röntgen Ray Society, September, 1920.

INJECTIONS OF BISMUTH INTO BRONCHI

The bismuth mixture would permeate many of the bronchial branches, be retained long enough to enable him to obtain satisfactory röntgenograms, and then would be expectorated. Such an occurrence, whether accidental or intentional, did not seem to seriously disturb the patient.

The experience mentioned above strengthened his belief that if accidental entrance could occur without danger, injections might be done deliberately and, combined with Röntgen examination, be used for diagnostic purposes.

Dr. Chevalier Jackson, of Philadelphia, during 1918, reported a case before the American Laryngological Association, in which the main bronchi on the right side were outlined röntgenographically, after insufflating dry bismuth through the 'scope.

Drs. J. C. Bullowa and C. Gottlieb, of New York, in 1919, reported some experimental studies on living animals in which the bronchi had been injected with bismuth and barium mixtures, röntgenographic observations of which brought out details of the bronchial tree heretofore never thought possible.

So far as we are able to ascertain, it was not until early in 1920 that any successful efforts were made to röntgenographically outline lung cavities after the injection of opaque substances through the bronchoscope. In May, 1920, Doctor Lynah, of New York, presented a short preliminary report on the subject before the American Laryngological Association; he reported two cases of lung abscess which had been successfully mapped out röntgenographically after the injection, bronoscopically, of aqueous and oily mixtures of bismuth subcarbonate directly into the area of diseased lung; both these patients have since been repeatedly examined by the authors and are included in the five cases reported in this communication.

CASE I.—A man, aged twenty-six years, who developed a lung abscess in July, 1919, after having aspirated sea-water while in swimming. He went out too far, became exhausted and went under; was hauled out and, by first-aid measures, soon revived.

One week later he suffered from what was supposed to be broncho-pneumonia; there was a great deal of foul expectoration at that time.

Within one month the acute symptoms had subsided, but he continued to expectorate large quantities of pus. He was sent to New Platz, N. Y., with a diagnosis of pulmonary tuberculosis even though no tubercle bacilli were found in the sputum. There he had several hemorrhages: the sputum showed numerous streptococci. He had fever and complained of having a "bubbling" sensation in his right chest. There were several night sweats. In February, 1920, the patient consulted Dr. F. W. Corwin, of Newark, N. J., who referred him to Doctor Lynah for bronchoscopic examination.

Röntgenographic studies made by Doctor Corwin showed a definite shadow over the right lower lobe surrounded by a "pus-soaked"

LYNAH AND STEWART

area of infiltrated lung tissue. The diaphragm was attached and pulled upward. The röntgenologist in his report stated that there was a fluid level and gas bubble in an abscess cavity; this, however, Doctor Lynah was unable to make out. There was profuse expectoration of foul-smelling pus, and the patient stated that he had coughed up as much as would fill two large preserve jars every twenty-four hours.

He was bronchoscoped after further study of the röntgenograms. The bronchoscopist noted a profuse discharge of pus pour-

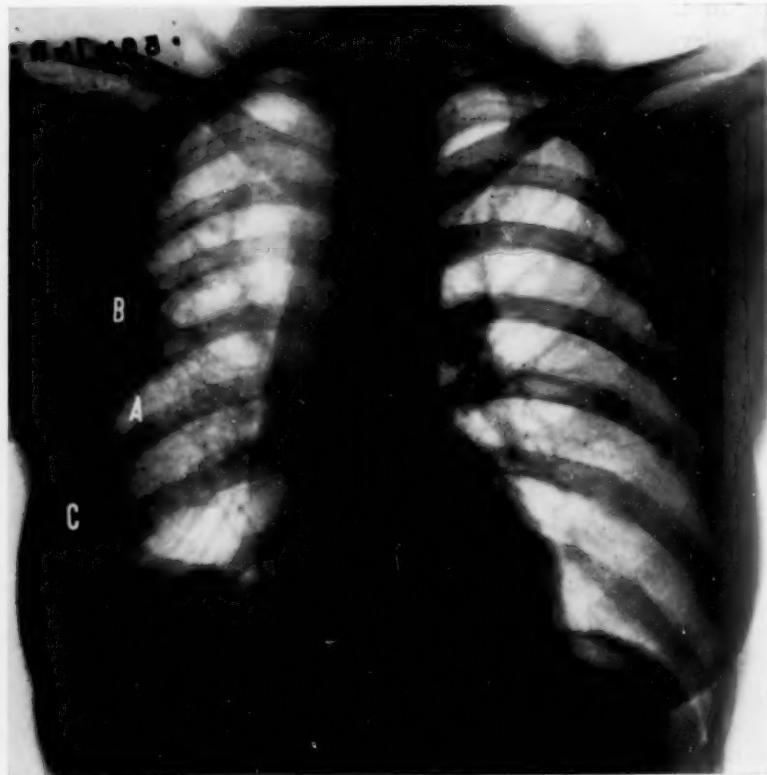


FIG. 1. (Case III).—Bronchiectasis before injection. *A*, area of diseased lung; *B*, resected ribs; *C*, thickened pleura with bands of adhesions "hooking up" the diaphragm.

ing out of the mouth of the 'scope. It was very foul smelling and blood tinged. A 7-mm. bronchoscope was introduced so as to be able to study and explore the lower lobe branches. After thorough evacuation of the pus-filled bronchi, the superior lobe branch on the right side was examined and found, on coughing, to be free from pus. Pus was noted coming out of the right middle lobe branch, which was directly anterior, but, after this branch was sucked out, and the patient instructed to cough, no pus was in evidence. The lower lobe branches were filled with pus; this was removed by suction and each branch examined in turn and the patient instructed

INJECTIONS OF BISMUTH INTO BRONCHI

to cough—by this means the branch bronchus from which the pus was coming could be definitely located. The small, but constant ejection of pus with each cough, pointed toward the right anterior branch; this branch was sucked out; however, pus appeared in the mouth of the bronchus with each cough in spite of suction; the long slanting end of the bronchoscope was then insinuated into this branch. It was now noted that there were many granulations present which bled freely. About one ounce of bloody pus was aspirated at this time into a sterile bottle and examined by Dr. George

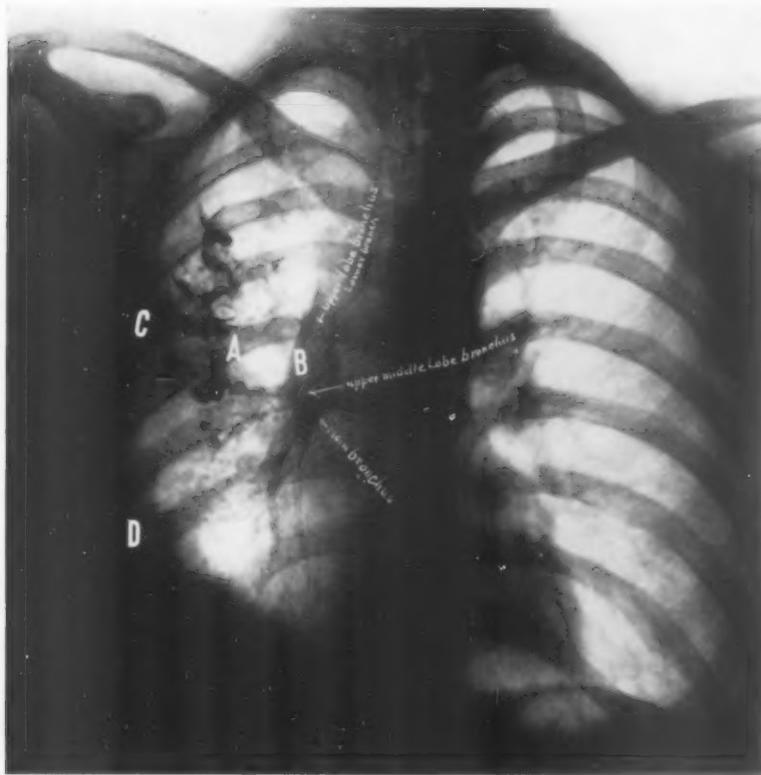


FIG. 2.—(Case III).—Bronchiectasis after injection. A, area of diseased lung cavities outlined with bismuth; B, right main bronchus with its upper and lower branches; C, resected ribs; D, thickened pleura with diaphragm "hooked up" with adhesions.

S. Dixon, of the New York Eye and Ear Infirmary, who reported as follows: "The pus removed bronchoscopically from the lung abscess of Mr. F. H. shows a pure culture of Friedlander bacillus." This was extremely interesting, for the most virulent cases which we see in the summer caused by swimming about New York Harbor are usually due to the Friedlander bacillus, one of the colon group. This man had a lung abscess caused by the inspiration of sea-water about New York harbor.

For definite lung mapping the abscess cavity was injected the following week with a mixture of bismuth subcarbonate in olive oil

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(1-2). The right anterior branch was injected around a corner by a specially made curved spiral canula; 8 c.c. of bismuth mixture was injected slowly so as not to infiltrate the surrounding lung tissue, and within five minutes from this time the patient was fluoroscoped by Dr. Charles Gottlieb, and some very interesting observations made. By fluoroscopy the cavities filled with the opaque mixture could be distinctly seen. Röntgenograms were also taken in all positions and a set of stereoscopic plates made. Within ten minutes the patient was again fluoroscoped and the bismuth mixture was seen coming out of the abscess cavity and flowing upward.

He had not coughed up to this time for he was breathing as quiet as possible. He did have considerable cough, however, immediately after the removal of the bronchoscope, but the fluoroscopic studies made by Doctors Gottlieb, Corwin and Lynah, did not show any bismuth in the bronchi; it was only in the abscess cavities. While the bismuth was coming out of the abscess cavities into the bronchial tree, it was noted that it did not flow downward but upward, and röntgenograms taken at the time showed the middle and superior lobe branches well outlined by the opaque mixture while the lower lobe branches remained free. Shortly after, the patient complained of such bubbling, that he was compelled to cough, and expectorated about 2 c.c. of the bismuth mixture.

From these observations, Doctors Gottlieb and Lynah agree that probably there is another mechanism besides cough and the action of cilia, which causes expulsion of secretions from the tracheo-bronchial tree.

Röntgenograms taken before the injection did not show a definite outline of the abscess.

Another injection of bismuth was made one month later, at which time the röntgenographic studies were made by Doctor Stewart at the Lenox Hill Hospital, who reported as follows:

Fluoroscopic and röntgenographic examination, to ascertain how long the bismuth would remain in the abscess cavities and also how long it remained in the lobular structure into which it had infiltrated, showed that the bismuth mixture started to make its exit from the bronchial tree within a short time after injection. It remained much longer in the abscess cavities and lobular structures, but eventually disappeared. In abscess cavities it may remain from two weeks to two months, the shadow growing less opaque until it finally disappears. This perhaps accounts for the improvement of the patients and the diminution of the quantity of pus expectorated and the disappearance of odor. The injection of bismuth mixtures, while done for the purpose of outlining the lung in order to definitely locate the abscess cavities, seemed to have a beneficial effect on the patient. There was no odor to the pus expectorated after the second injection—this was so pronounced that the patient noticed it himself and said that he no longer had a foul breath, for the bad smell and taste had disappeared.

This case is still under observation.

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CASE II.—A young lady of twenty years was seen in consultation with Drs. Willy Meyer and Richard Jordon. The patient was admitted to the Lenox Hill Hospital and bronchoscopied shortly thereafter. Röntgenograms showed what appeared to be a very large abscess in the left upper lobe well out toward the periphery, which from the "pus-soaked," spongy lung structure surrounding it, appeared much larger than it really was, and also suggested some pleural involvement.

The patient had had a tonsillectomy performed one week before admission by an expert laryngologist. At the time of admission she was expectorating 250 c.c. of pus every twenty-four hours, and her general condition was poor.

Bronchoscopy with a 7-mm. tube showed pus pouring out of the bronchoscopic tube; all the pus having been sucked out, the left bronchus was entered. There was an œdematosus bronchial stenosis of the upper lobe orifice with a small opening from which free pus was expelled with each cough; in addition, a membranous plaque was present which also obstructed drainage from the upper lobe. The long slanting end of the 7-mm. tube was gently introduced into the mouth of the upper lobe orifice separating the œdematosus stricture; the membranous plaque was removed by suction. After evacuating as well as possible the upper lobe branch, the lower lobe branches were examined but no pus was found in same. The upper lobe branch was again entered and the patient instructed to cough; with each expulsive cough there would be a gush of pus from this branch. The bronchus was apparently draining much more freely since the œdematosus stricture had been opened. With a 10-inch vacuum the bronchus was once more aspirated and after fifteen minutes the bronchoscopic tube removed.

The following week the patient had improved somewhat, but the amount of pus had not greatly decreased.

Doctor Lynah again bronchoscopically aspirated the upper lobe branch, and then decided to inject the bismuth and oil mixture in order to röntgenographically map out the abscess cavity. With the curved spiral canula, 8 c.c. of bismuth subcarbonate in olive oil was injected too forcibly so that some of it squirted out of the spiral and passed downward into the lower lobe branches—leakage out of the spiral will not occur if the bismuth is injected slowly, nor will it infiltrate the lobular structures of the lung. The upper lobe branches of the lung abscess were also injected, the bismuth sticking to the wall of the cavity and thus marking it out. Several smaller abscesses were now noted, whereas, in the plate before injection, the cavity was interpreted as being very large. The bismuth mixture did not infiltrate the lobular structures in the upper lobe. Stereoscopic plates showed the abscess cavities well anterior and out toward the periphery, while the mass, which had leaked down into the lower lobe branches, was well posterior. A lateral plate taken at this time showed the relations of the upper anterior lobe abscess cavity, which was clearly defined, to the posterior dull,

opaque, fan-shaped are due to gravitation into the dorsal branch.

The bismuth was expelled from the lung, as in the other patient, within twenty minutes after the injection. As some of the bismuth had leaked downward into the lower lobe branches, it was impossible to state whether or not the bismuth started immediately to be expelled outward, as in the first patient, or whether it had gravitated into the lower lobe branches after it started to be expelled.

The patient was studied from time to time with the fluoroscopic screen and further röntgenograms taken. At the end of one week there was still bismuth present, both in the abscess cavity and in the lower lobe of the lung where no abscess existed; this looked somewhat like an abscess cavity, but was seen röntgenographically as an irregular area of opaque dulness and did not have the metallic lustre of the bismuth in the abscess; this is one of the distinguishing points between infiltration of bismuth into the lobular structure of the lung and bismuth in an abscess cavity.

The patient improved after the injection, in a manner similar to Case I. The pus decreased from her lung, and the amount of measured sputum in twenty-four hours decreased from 250 c.c. to 30 c.c. The odor was decidedly less and the patient's general health improved.

Bismuth was still present in the lung when fluoroscoped ten days after injection, although both shadows were diminishing in density and the lung abscess was apparently clearing up.

The patient suffered no discomforts following two injections of bismuth into her lung. She ate and slept well and had but little cough. She was bronchoscopyed twice since the injection and we were not able to recover any of the bismuth by suction, even though it was still present in the lung. At a later bronchoscopic examination there was very little pus recovered by suction and no pus was expelled from the bronchus when the patient was instructed to cough.

The patient is still under observation.

CASE III.—A female, S. M., aged twenty-five years. On March 26, 1918, she had her tonsils and adenoids removed. Ten days following the operation the patient began coughing up small quantities of foul-smelling sputum, thick and yellowish in character; the amount gradually increased and occasionally the sputum was streaked with blood. There was pain and soreness in the lower part of chest.

She was operated on in May, 1919. Rib resection was performed and the cavity Dakinized; no abscess was found. The following September the incision was reopened and the tube placed in the cavity; there was no drainage; very little improvement occurred. In November, 1919, a new incision was made lower down with resection of a rib; a tube was left in the cavity, but no drainage occurred. In January, 1920, the incision was reopened and extended backward. An abscess was opened and a tube left in for drainage, which amounted to four ounces on the first day and two ounces on the second day. The discharge gradually decreased. The tube was removed and the wound healed.

About six weeks later she began coughing and raising foul-

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smelling sputum again and gradually became worse until she was admitted to the Lenox Hill Hospital, on May 17, 1920.

On May 22, 1920, a preliminary fluoroscopic combined with stereoröntgenographic examination showed evidence of pleuritic thickening involving the upper and middle lobes on the right side; the right diaphragm was partially fixed with adhesions. In the lower portion of the upper right and the upper portion of the middle right lobes there was increased density with here and there evidence of cavitation.

The patient was bronchoscopyed on May 25, 1920. Abundant purulent secretion was discharging from the upper lobe. Eight c.c. solution of bismuth subcarbonate in sterile olive oil (1-2) was injected in the upper lobe bronchus; this was followed by a fluoroscopic as well as a stereoröntgenographic examination, which showed that some of the bismuth solution had reached the diseased area, but not sufficient to satisfactorily map out the cavities.

A Röntgen reexamination, on June 9th, showed much the same condition as reported on May 22nd. Most of the bismuth had disappeared.

On July 8th the patient was again bronchoscopyed, the main upper lobe being injected as previously. The stereoröntgenograms, taken almost immediately after the injection, showed with excellent detail the numerous cavities in the lower portion of the upper and the upper portion of the middle right lobes.

The patient is still under observation and shows continued improvement.

CASE IV.—A. L., a young girl, aged twenty years, was admitted to the Lenox Hill Hospital in June, 1920, with the following history:

Tonsils had been removed two years previously. Following the operation she was taken home in an open car, with considerable exposure. Pneumonia developed; the cough continued, and two weeks later she began expectorating large quantities of foul-smelling pus. This condition persisted up to the time of her admission to the hospital.

A preliminary fluoroscopic combined with stereoröntgenographic examination, on June 19, 1920, showed marked pleuritic thickening over the middle and lower right lobe; the right diaphragm was "hooked up" with adhesions and there was considerable increased density in the middle and lower right with evidence of cavitation, especially in the lower lobe.

On June 20, 1920, bronchoscopic examination showed pus coming from the middle and lower right lobes; none from the upper. A solution of 8 c.c. of bismuth subcarbonate in sterilized olive oil was injected into the bronchi of the middle and lower right.

Röntgen examination, made as soon as possible after the injection, showed the bronchi within the diseased area well outlined, with numerous cavities clearly demonstrated.

When the patient entered the hospital she expectorated 300 to 500 c.c. per day. Since the injection gradual improvement has

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occurred with marked diminution in the quantity of expectoration.

The patient is still under observation.

CASE V.—E. E., male, aged twenty-four years, entered the Lenox Hill Hospital on June 18, 1920, with following history:

Had tonsils removed June 5, 1920; six days later developed a cough which became productive on about the ninth day. On admittance his chief complaint was cough with expectoration, and pain in joints.

June 23, 1920, a preliminary Röntgen examination was made which revealed a dense triangular area in the lower portion of the upper right lobe; in the centre of this pus-soaked, spongy area of infiltrated lung tissue a fluid level with an air bubble above could be made out, indicating a large abscess.

On June 29th he was bronchoscopied, a 9-mm. tube being used. Pus was seen coming from the right upper lobe bronchus only. About 10 c.c. of bismuth subcarbonate in sterilized olive oil (1-2) was injected into the right upper bronchus; this was followed by Röntgen examination which showed the lower bronchus outlined by the injection, but very little, if any, having passed into the diseased area.

He was again bronchoscopied on July 8th. Pus was still obtained from the right upper bronchus which was again injected with bismuth solution. Fluoroscopy and stereoröntgenograms showed bismuth outlining the numerous cavities; some of the mixture had infiltrated into the lobular structures well out toward the periphery of the upper portion of the dense area.

The quantity of sputa gradually diminished until July 19th, when it had practically disappeared and the arthritic symptoms had greatly improved.

A stereoröntgenographic reëxamination on July 26th showed gradual disappearance of the bismuth except where it had penetrated the lobular structures.

The patient is still under observation.

SUMMARY

1. Bismuth mixtures can be injected into the bronchi and lungs of a living patient without danger.

2. The injection of an opaque substance into the lung of the living patient will open an enormous field of usefulness in the study of cough, the expulsion of substances from the lung, and lung drainage. It will also aid in localizing bronchial strictures in the same manner as in the oesophagus. Furthermore, it will be of the greatest aid to the thoracic surgeon by mapping out the abscess cavity in the respective lobe of the lung.

3. A definite lung abscess cavity is seldom seen bronchoscopically. Pus is usually seen coming from a branch bronchus, although the abscess may be well around the corner, and not in that portion of the lung from

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which the pus is oozing. An injection of bismuth mixture or some other opaque mixture will "clear up" this error.

4. Bismuth when it enters the abscess cavity is recognized by its metallic lustre, whereas, when it is in the lobular lung structure, it is discerned as a dull, opaque area. Pus diffuses and soaks the lobular structure in a manner similar to bismuth; this often makes the involved area appear many times larger than it really is.

5. The bismuth mixtures injected in these patients was 8 c.c. of bismuth subcarbonate in pure olive oil (1-2). The mixture is rendered sterile by boiling before injection.

6. The injection should be made slowly and not with a "squirt" or else the röntgenographic observations may be spoiled by bismuth soaking the lung structure surrounding the diseased area.

7. It seems from these preliminary studies that cough and action of cilia are not the only means of expelling secretions.

8. While bismuth mixtures were originally injected for the purpose of lung mapping in cases of lung abscess cavities, they seem to have been of therapeutic benefit to the five patients upon whom they were tried. So far the procedure has done no harm.

9. While the fluoroscopic examination is important, stereoröntgenographic examination is the best means of localizing the cavitations.

10. Experience has shown that the Röntgen examination should be made almost immediately after the removal of the bronchoscope, otherwise the patient, in a fit of coughing, will remove much of the bismuth from the involved lung.

TECHNIC FOR REMOVAL OF FOREIGN BODIES UNDER DIRECT FLUOROSCOPIC GUIDANCE

By L. W. GROVE, M.D.
OF ATLANTA, GA.

THE extreme difficulties incident to extraction of foreign bodies have long been well established. Stimulated by this fact, and the recent work of Braasch in removal of stones from the kidney, which emphasizes the applicability of this method to civil practice and the possibility of a wider field for operative fluoroscopic methods, I offer the discussion of the following technic, my knowledge of the method being based on experience gained from the removal of four hundred and eighty-five foreign bodies while Chief of the Surgical Service, Base Hospital 202, Orleans, France, and as Associate Chief of Service, General Hospital 41, Staten Island, New York.

After a trial of all the modern localization methods offered for extraction of foreign bodies, the method about to be described was adopted as being the surest, safest and quickest, and in our hands resulting in one hundred per cent. successful removals.

For the successful application of this technic, there is required a dark fluoroscopic room suitable for operating purposes, an operating fluoroscopic table with adjustable Röntgen-ray tube, a sharp pointed metal indicator, a headlight for the operator, and a screened light for the anæsthetist. If the operator is well trained in the use of the fluoroscopic screen, this technic might be undertaken without the aid of a röntgenologist, otherwise the advice and consultation of the röntgenologist is much to be desired.

Technic.—First, a careful fluoroscopic study of the case is necessary before time of operation to determine the advisability of extraction, the number and size of foreign bodies to be removed, and an important feature, the best method of approach; on this depends the success or failure of extraction.

Exact localization of the foreign bodies is done in the following way: With the patient under general anæsthesia, the room is darkened and the foreign body is focused in the direct ray between the tube and screen. Now the metal indicator is placed directly over the foreign body, the tube box is shifted in the long axis of the field, and the rate and distance of the foreign body and indicator are noted. The body of density, whether foreign body or indicator, nearer the tube, falling in the line of ray first, gives the appearance of travelling the faster, and hence a greater distance. At this stage the indicator is raised or lowered, depending on whether it or the foreign body is travelling faster. If faster, it is raised, and *vice versa*. This is continued until the indicator and foreign body move together at the same rate of speed and same distance, indicating that they are the same distance from the tube. This indicates that the foreign body lying in the

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perpendicular or direct ray between the screen and tube lies also in a line continuous with the tip of the indicator, which is at a right angle to the line of direct ray. At this stage the switch is thrown and tube allowed to cool, while with the use of the headlight, a small incision through skin and fascia is made. Now, with a pair of heavy-jawed forceps placed in incision, the ray is again sent through and the forceps gently but firmly thrust in onto the foreign body. Now with a few movements of the forceps for blunt dissection, the foreign body is freed, grasped and withdrawn. The switch is thrown, a couple of sutures placed, or the wound drained, as indicated, and a dressing applied.

At times, owing to the position of the foreign body or its relation to bone, it cannot be approached at a right angle to the direct ray, and in this event the technic becomes somewhat more difficult, but in the hands of one skilled in the technic the operation is quickly and safely done, usually not consuming more than two to four minutes.

Reference to the above technic has recently been made by Dr. Herbert A. Potts, Chicago, Illinois, in a manuscript published by him on Oral and Plastic Surgery in France, in which he gave me credit for approximately four hundred extractions, but there was no effort at a careful description of technic.

The four hundred and eighty-five extractions above cited occurred in the following locations: pericardium, three; lung and pleural cavity, twelve; bone and joint, fifteen; soft tissue, four hundred and fifty-five.

There are certain locations in which foreign bodies lend themselves better to extraction by means of open dissection, the fluoroscope being used for fractional localization, or indicator. This is especially true as shown in the three cases of removal of foreign bodies from the pericardium. This is also true of foreign bodies in close proximity to the vital structures of the neck. In these cases the method of localization is the same, the operation being done on the fluoroscopic table, but through open dissection, with the fluoroscope used when needed. It can readily be appreciated that the blind approach, as described, might be a very hazardous undertaking in the case of foreign bodies in the pericardium, or deep structures of the neck.

Cases of foreign bodies in the lung deserve special mention, and certain special features in technic are necessary. The same method of localization is employed, the same method of blind approach, but with special precautions against an artificial pneumothorax. This is done in the following way:

At the point indicated on the chest wall the skin is grasped and held firmly while the incision is made. The skin still being held firmly, the forceps are thrust in through the muscle and pleura and the foreign body extracted. As the foreign body is withdrawn from the chest, the skin is again grasped firmly and is held firmly between the fingers, while two deep mattress sutures are placed, including skin and intercostal muscles. This precaution prevents the entrance of air in sufficient quantities to cause a perceptible degree of pneumothorax and it can be seen that the function of the lung is not disturbed. Owing to the intrathoracic pressure being main-

tained at approximately normal, hemorrhage is controlled. In no case of the ten of foreign bodies in the lung was there any appreciable embarrassment in respiration, or any appreciable hemorrhage. Of the five cases with associated pulmonary abscess the same technic was used with the exception of drainage tubes being placed, following resection of rib. In two of the five cases a two-stage operation was done, the first operation including resection of rib with establishment of adhesions between parietal and visceral pleura. This was followed at the proper time by removal of the foreign body by use of the above technic, with sufficient drainage.

I especially mention the advantages of the above method of localization and approach in isolated, small pulmonary abscesses over the old method of localization by aspiration. The abscess casts a distinct shadow, and can be localized and approached in the same manner as a foreign body.

In the cases of foreign bodies in joints and bones, either the blind method of approach or an open dissection with the fluoroscope as an indicator, can be used, depending on location of foreign body.

In foreign bodies in the medullary canal we have routinely used the open dissection, in some instances a window being cut by the use of the twin saw.

The method is not especially applicable to foreign bodies in the brain. It might be done successfully, but these cases lend themselves better to extraction by use of the magnet. The two cases of foreign bodies in the brain observed by me were showing no symptoms. The foreign bodies being rather inaccessible, no attempt was made at removal.

Even with the most accurate localization methods, most expertly done, there will result a certain large percentage of failures of extraction. This is brought about by several factors, namely, the variable contour of the field; often, change in position, due to change in position of patient on the table; change in position resulting from traction of wound edges; bad judgment as to method of approach, impossible of avoidance, incision often being made on wrong side of bone; and many mechanical factors that might be mentioned which tends towards failure. A foreign body in a sinus or tract might move, which would necessarily discredit any methods of localization. With the above technic, this is eliminated, for the reason that the foreign body is under the direct eye, and can be traced and followed. In the case of foreign bodies in the chest, pleural cavity or lung, with the localization method it is necessary to do an open thoracotomy with wide exposure, it being often necessary even to deliver a portion of the lung, resulting in shock, trauma, and of course a pneumothorax with collapsed lung.

We have all had very unhappy experiences in efforts at removal of foreign bodies, especially foreign bodies in hands and feet, and I am sure that a method so sure and accurate, resulting in so little trauma, should be accepted as worthy of adoption.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held November 1, 1920

The President, DR. GEORGE G. ROSS, in the Chair

BONE TRANSPLANT FROM CREST OF ILIUM TO MANDIBLE

DR. ROBERT H. IVY presented a man, aged twenty-seven years, who when seven years of age had a large section of the left side of the mandible removed, comprising the full thickness of the bone, for a large growth which a well-known surgeon diagnosed as sarcoma, this diagnosis being confirmed pathologically. Since that time he has worn a prosthetic appliance which partially overcame the deformity and enabled him to masticate food fairly well. Of late years, however, changes in the shape of the jaw and in position of the teeth affected the fit of the appliance, so that it was rapidly becoming useless. Examination revealed (Fig. 1) an absence of something over two inches of the left side of the mandible from the canine region to the angle. A small portion of the ascending ramus with coronoid and condyloid processes was present, this fragment being movable at the joint. The remainder of the mandible showed great instability and a marked tendency to swing over to the left side, with consequent loss of facial balance and interference with function. The success attending bone grafting in cases of ununited gunshot fracture of the mandible during the recent war led him to attempt a bone transplant in this case. Cast silver splints were made by Dr. J. E. Aiguier, fixing the right side of the mandible in proper relation with the upper jaw. On March 17, 1920, at St. Agnes' Hospital, under ether intrapharyngeal anaesthesia, an incision was made over the region of lost substance, the ends of the fragments were exposed and freshened, and a graft $2\frac{1}{2}$ inches long was removed from the crest of the ilium and inserted to fill the gap, being attached to the fragments by means of silver wire. The wound was closed in two layers. Some suppuration occurred, part of the surface of the graft being exposed for several weeks, but the wound eventually closed, and the vitality of the graft was not interfered with. At the present time there is firm union at both ends of the graft, and the jaw is in good position (Fig. 2). An artificial denture will shortly be prepared. The operation left a depressed scar, adherent to the bone. On October 15, 1920, at the Medico-Chirurgical Hospital, the scar was excised, the edges were undermined for some distance, and after complete haemostasis a strip of fascia lata from the left thigh was inserted into the pocket under the skin, being retained in place with a few catgut

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FIG. 1.—Radiograph made by Dr. H. K. Pancoast, showing loss of substance in the lower jaw.



FIG. 2.—Radiograph made by Dr. H. K. Pancoast, showing graft in place. Clinically, firm union is present, although this is not altogether apparent in the radiograph as far as the anterior end of the graft is concerned.

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sutures. The wound was closed with interrupted sutures of horsehair. In this manner the depression was obliterated. The wound healed without complications, the sutures were removed on the sixth day, and in ten days the patient was up and about.

Payr, of Griefswald (*Zeitschr. f. Chir.*, September 5, 1908), employed a piece of rib to replace loss of substance of the mandible. Oppel, of Petrograd, in 1910 used osteo-periosteal fragments from the clavicle. Vorschütz, of Cologne (*Deutsch. Zeitschr. für Chir.*, September, 1911), reports two cases in which a graft was taken from the crest of the tibia. In both cases the transplanted bone was extruded, but sufficient periosteum remained for regeneration to occur. Abadie, of Oran (*Bull. et mém. Soc. de Chir. de Paris*, 1912, xxxviii, 649), records the use of a free rib graft following resection of the mandible for follicular cyst. The functional and cosmetic results were good, although the bone was apparently absorbed and replaced by dense fibrous tissue.

CALCULUS IN WHARTON'S DUCT

DR. ROBERT H. IVY presented a man who for six days had complained of pain and swelling beneath the tongue on the right side of the mouth,

and a swelling in the right submaxillary region of the neck, all of which symptoms gradually grew worse. The swelling in the neck



FIG. 3.—Large dental X-ray film placed horizontally between teeth showing calculus. Made by Dr. L. M. Ennis.

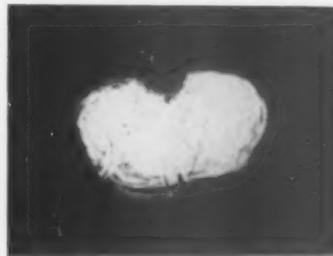


FIG. 4.—Calculus.

partly subsided after two days, but again increased. The patient stated that he had had the same symptoms nine years before, but that they had passed away gradually without treatment. Examination revealed a small hard, tender lump just beneath the mucous membrane on the right side of the floor of the mouth opposite the second molar tooth. There was also a circumscribed, oval, rather soft, slightly tender swelling just beneath the angle of the jaw on the same side. Upward pressure on this made the lump in the mouth more prominent. At first radiographic examination was negative, but a second film placed well back horizontally between the teeth showed a large opaque body (Fig. 3) in the region of Wharton's

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duct. Through an incision in the floor of the mouth a large oval calculus, 2.3 by 1.9 by 1.4 cm. in size and weighing 0.9 grm., was exposed and removed (Fig. 4). A small iodoform gauze drain was placed in the wound, which healed in a few days without complications.

Erdman has recently reported (*Jour. A. M. A.*, May 22, 1920, p. 1447) five cases of calculus in salivary ducts, and states that about three hundred cases have been recorded altogether. It is probable, however, that the condition is commoner than these figures would indicate, many cases occurring without being reported. About two-thirds of the cases involve Wharton's duct, 20 per cent. Stenson's duct, while in a small number the sublingual gland is involved. The largest stone in Erdman's series was 1.3 cm. in length. The principal component of salivary calculi is calcium phosphate, other substances being calcium carbonate and organic matter.

Important points in the diagnosis are the presence of a hard, tender swelling in the floor of the mouth associated with submaxillary enlargement which varies in size from time to time, and the radiographic findings. Combined internal and external palpation is of great value. Radiographic findings are frequently negative, owing to faulty technic. A large dental film placed horizontally between the teeth, as far back in the mouth as possible, and the rays directed from beneath the chin, will usually reveal the calculus. The commonest condition causing error in diagnosis is dento-alveolar infection with enlarged submaxillary lymph-nodes.

DR. EDWARD B. HODGE reported that he had had four or five cases; the youngest, a colored child nine years of age. Another case was in a nurse, who refused operation and suffered for a year and a half, when suppuration forced her to operation. Here the stone was found in the submaxillary gland, where it had been located by previous X-ray.

DR. JOHN B. CARNETT said that eight or ten years ago he saw three cases of stone in Wharton's duct in the course of a few months. In none of them was the stone nearly as large as the one shown. Skiagraphs taken of two of them were negative. There were four stones in the three patients, and in all three patients there was a characteristic mild colic while partaking of food. The submaxillary gland on the affected side enlarged in all three during meals, and in one case pain was so severe that the patient left the table frequently before completing the meal. In all three patients simple incision over the stone allowed its easy evacuation. The incisions closed up without trouble. All the patients were young adults and none had had any further trouble a year later, and one seen during past month has had no further difficulty.

FRACTURES INVOLVING JOINTS

DR. W. E. LEE and DR. WALTER LEVERING presented three fracture cases from the service of Doctor Lee, the first two treated at the Pennsylvania Hospital, and the last at the Germantown Hospital. Although

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the fractures are of different regions, namely, just above the elbow, the knee and the ankle, respectively, there are certain points of similarity about them which are worth considering. (1) In all there was a history of violent trauma. (2) In all there was considerable displacement of the fragments. (3) In all a joint was involved either directly or indirectly. (4) The treatment was somewhat the same, namely, by reduction under general anaesthesia, and fixation with extreme flexion. (5) The end-results in all were satisfactory.

The first case, Miss J. W., aged twenty-one years, on March 11, 1920,

FIG. 5.



FIG. 6.



FIG. 7.



FIG. 8.



FIGS. 5, 6, 7, 8.—Supracondylar fracture of humerus extending into elbow joint.

while working at a bookbinding machine got her right arm caught and was drawn forward. The pain was so intense that she could not explain the manner in which her arm was twisted. She was brought to the hospital at once, and was dressed in the receiving ward on an anterior straight splint. Arm in extension. Receiving ward diagnosis, supracondylar fracture of humerus. She returned the following day, was X-rayed and admitted to the ward. The X-ray (Figs. 5 and 6) showed a supracondylar fracture of the humerus comminuted, of the T-shape variety, involving the trochlear surface of the joint. There was complete displacement, the lower fragments being anterior. At the end of a week she was dis-

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charged from the hospital and sent to the dispensary. Here it was found that the deformity had not been corrected and she was returned to the hospital. On March 25th, fourteen days from the time of the injury, under ether anaesthesia, Doctor Lee reduced the deformity and dressed

FIG. 9.



FIG. 10.



FIGS. 9, 10.—Ankylosis imminent.



FIGS. 11, 12.—Range of motion on completion of treatment in case shown in Figs. 5 and 6.

the arm in Jones position. X-ray examination (Figs. 7 and 8) then showed excellent position of the fragments. Patient was then treated in the dispensary. X-ray examination on May 14th showed some absorption of the articular cartilages, and the röntgenologist suggested that ankylosis was imminent (Figs. 9 and 10). Massage and active and passive motion was

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kept up, and a final X-ray taken October 30th shows what appears to be a perfect joint (Figs. 11 and 12). The patient has complete flexion, 170 degrees extension, and complete pronation and supination. She has returned to her original work and her earning power has not been reduced.

The second case, Mrs. E. B., aged thirty-one years, on March 6th was thrown from an automobile, landed on her feet and turned her ankle under her. She was brought to the hospital immediately, a diagnosis of Pott's fracture made, dressed in a Thomas splint, with a stocking extension. X-ray (Fig. 13) examination showed comminuted fracture of the right fibula, a short distance above the malleolus. There was also a fracture

FIG. 13.



FIG. 14.

FIG. 13.—Fracture of fibula and tibia involving ankle joint.
FIG. 14.—Result after operative correction of deformity.

of the tibia, at the tibiofibular articulation. There was marked backward displacement of the foot and distal fragment of the fibula. On March 12th, six days after the injury, under nitrous oxide anaesthesia, tenotomy of the tendon of Achilles was done, the deformity reduced, and the foot put in a plaster case in extreme flexion and internal rotation. X-ray examination (Fig. 14) showed excellent position of the fragments. The end-results at time of reporting this case show complete function and no deformity about the ankle.

The third case, a boy, A. Mc., aged eleven years, on July 18, 1920, fell from a hay loft a distance of about eleven feet. His left leg went into a post hole, and he was thrown forward. He was brought to the hospital

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at once. Examination showed swelling and crepitus just above the left knee. The leg in hyperextension. X-ray examination showed an epiphyseal fracture of the femur and complete backward displacement of the upper fragment (Fig. 15); under ether anaesthesia the deformity was reduced and the knee dressed in acute flexion (Fig. 16). Patient was left in this position until the thirty-fifth day, when it was found he had contraction of the hamstring tendons and could not extend the leg. He was again anaesthetized and the adhesions broken up, the leg being dressed on a posterior splint and considerable pressure put on the knee to promote extension. After three weeks of this it was found the boy



FIG. 15.—Separation of the lower epiphysis of femur. FIG. 16.—Separated epiphysis restored to place by acute flexion of knee.

had a toe-drop, due probably to pressure of bandage on a nerve. He was discharged from the hospital in September and sent to the dispensary. At the time of his discharge X-ray (Fig. 17) shows good union and excellent position of the fragments. Function of the knee was complete; he still, however, has slight toe-drop. This is undergoing rapid improvement.

DR. A. BRUCE GILL said that orthopaedic surgeons are frequently called upon to examine or treat cases of fractures in the neighborhood of joints, because the patients present a disability of the extremity which persists oftentimes many months after the fracture. This is particularly true of fractures at the wrist and the elbow. If a fracture at the wrist is succeeded by swelling of the hand and fingers which persists, not infrequently a condition of fibrous ankylosis of the joints of the fingers, particularly of the metacarpophalangeal joints, results. This ankylosis is due particularly to the swelling; that is, to the interference with circulation. The

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disability which results from a Colles fracture is nearly always due to the ankylosis of the fingers rather than to any interference with the function of the wrist joint. If the fracture is properly reduced and proper dressing is applied, either the swelling does not occur, or if it has occurred, it subsides quickly after complete reduction is accomplished. If the swelling persists after a week or longer it should be considered as an indication that the fracture has not been reduced.

The surgeon cannot rely entirely on the X-ray examination. Sometimes the X-ray shows fairly good reduction of the fracture, but the swelling persists. At other times there is fairly marked displacement of the fracture, but there is no swelling of the hand, and the patient has no loss of function as a result of the fracture. The persistence of swelling should be a chief guide in the treatment of the fracture.

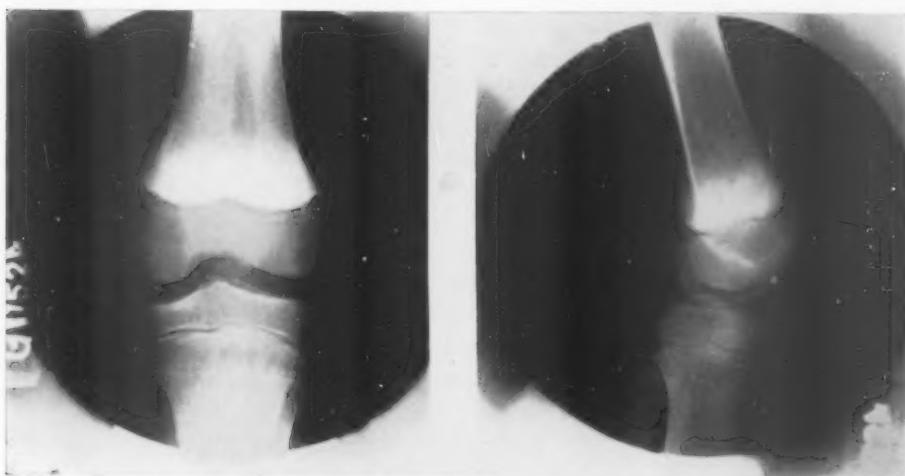


FIG. 17.—Ultimate result from treatment of case shown in Figs. 15 and 16.

In a similar manner, fracture of the lower end of the humerus may lead to long-continued disability or even permanent disability of the hand because of ischaemic paralysis, or Volkmann's contracture; or because of ankylosis of the fingers which has been caused by the persistent swelling of the hand. A proper reduction of the fracture before the first dressing will eliminate any danger of such untoward results. To dress the elbow in acute flexion without complete reduction of the fragments tends to produce a constriction of the vessels at the elbow, which may cause a Volkmann's contracture, or fibrous ankylosis of the joints of the hand.

He had seen cases of fracture of the upper end of the humerus or dislocations of the shoulder produce a long-continued disability of the hand which was due to this same fibrous ankylosis of the joints of the fingers. In practically all of these cases can be obtained a history that the hand remained swollen for a period of weeks during the treatment of the fracture or dislocation. One cannot emphasize too strongly the

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necessity of watching carefully for circulatory disturbances, for such disturbances usually indicate an incomplete reduction of the fracture, or, less commonly, an improper dressing.

PAPILLARY CYSTADENOMA OF THE BREAST

DR. JOHN H. GIBBON reported two cases of papillary cystadenoma of the breast and exhibited the specimens. Both cases had been operated upon within a week. The first was that of a woman, sixty-five years of age, operated upon at the Jefferson Hospital, October 26, 1920. She had had ten children and two miscarriages. Mass in the breast first noticed ten years ago. Other masses developed and about two years ago one of them was incised by her physician and a quantity of blood and pus evacuated. The breast contained several masses, the largest about the size of an egg, covered by thin skin and evidently containing dark fluid. Translucency was present in the largest mass. The swellings were grouped around the centre of the breast, the nipple was contracted and considerable fibrous tissue could be felt between the tumors. The breast was freely movable but an enlarged gland could be palpated in the axilla. Through a Stewart incision the breast with the great pectoral muscle and all the axillary glands and fat was removed. The glandular involvement was much more extensive than he had expected. On opening one of the cysts it was found to be filled with bloody fluid and at one point there was marked papillary outgrowth. A part of the cyst wall was calcareous. Microscopic diagnosis in this case was "papillary cystic adenocarcinoma of mamma with metastasis to the axillary lymph-nodes."

The second case was that of a woman forty years of age, operated upon at the Pennsylvania Hospital, October 27, 1920. This patient had never been pregnant. Had noticed a tumor in the left breast for six or seven years. It remained quiescent until about six months ago, since when it has progressively increased in size. Examination showed a multilocular, freely movable, fluctuating tumor in the outer and lower quadrant of the left breast. No glandular enlargement was detected. Through a Stewart incision the breast, with the sheath of the pectoral muscle and the axillary glands and fat, was removed. On opening one of the cysts, which presented on the posterior surface of the gland, it was found to be filled with a papillary outgrowth. Thinking that the condition was probably malignant, the great pectoral muscle was then removed and a more complete dissection of the axillary glands and fat made. The microscopic diagnosis in this case was "papillary intra-cystic fibro-adenoma." The lymph-glands in this case showed no evidence of metastasis.

The incidence of papillary cystadenoma of the far-advanced type represented in the cases shown is rather rare nowadays, because all cases of tumor of the breast are receiving much earlier treatment. The condition has been described by many writers under many names. It is the hydatid disease of Sir Astley Cooper, the serocystic sarcoma of

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Brodie, the cystosarcoma phylloides of Müller, and the proliferous cyst of Paget. Paget's description of the condition in his "Lectures on Pathology," 1853, is a most complete one, and he describes the clinical course of the disease in a very thorough manner.

During the past ten years the reporter had operated upon six cases of papillary cystadenoma and twenty-eight of fibrocystadenoma, which shows that the condition is not very rare. Of course, during this same period the cases of subinvolution-cysts of the breasts have been much more numerous than the two other types combined.

The classification of these cases has always been confusing because of the association of the fibrous and epithelial elements in the tumors. Collins Warren, however, in his "Surgical Oration" before the A. M. A., in Portland, 1905, clarified the difficulty by proposing the two terms, fibrocystadenoma and papillary cystadenoma. He reported twelve cases of the latter condition from the Massachusetts General Hospital and his own practice.

This disease is seen in women usually past forty-five and who have borne a great many children. The tumors grow slowly for years and are then apt to take on rapid growth. Rupture by ulceration took place quite frequently in the cases reported fifty years ago, and the growth taking on a fungoid character was considered sarcoma.

The skin in the later stages becomes thin, the cysts stand up prominently and are often translucent, as in one of the cases here reported. The tumors usually form about the nipple and much fibrous tissue can be felt between them. Fluctuation is distinct. Glandular involvement is rare. Paget reports a case in which there was glandular metastasis and recurrence, and in one of the speaker's own cases malignant glandular involvement was present. Bleeding from the nipple is considered one of the common symptoms, but it was present in neither of the cases, specimens of which he was exhibiting.

Clinically the condition must be looked upon as malignant, although in its early stages it is only mildly so. The differentiation from fibrocystadenoma, or what is commonly called cystic adenoma, can be made by macroscopic inspection of the cyst wall, which in the one case is smooth and in the other contains papillary outgrowth.

The treatment of this condition, of course, is amputation of the breast together with the removal of the axillary glands and fat, as it is impossible to tell whether or not an epitheliomatous change has occurred. He did not think that the absence of palpable glands in these cases is sufficient to justify one in omitting the dissection of the axilla.

RATIONAL TREATMENT OF FRACTURES OF THE TUBULAR BONES

DR. JOHN B. ROBERTS said that a gratifying sequel of the European war has been to dispel the delusion that a great group of closed fractures of the long bones must be subjected to adjustment of fragments by blood-spilling operations; as a consequence, the ability to obtain good results in such fractures, without resort to incisions for inspecting and fixing frag-

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ments, has been secured by many medical men. Thus the former craze for operative reduction has been much lessened. The treatment of open, contaminated and infected fractures, moreover, has been greatly improved by the investigation and experience of military surgeons. A rational study by the inductive method seems to him to establish these propositions:

The majority of closed fractures of long bones may be cured with good function and good anatomical result without exposing the bone by operation. Some open fractures of these bones, if kept aseptic, may be properly cured without exposing the bone by operation.

A moderate proportion of closed fractures only will need operative exposure of bone, to correct malposition of fragments; and some of these should have direct fixation.

Many open fractures, especially gunshot injuries, will require operation to convert contaminated fractures into aseptic fractures, and to permit primary closure of the wounds. Some of these open fractures will also need readjustment of fragments and possibly direct fixation of fragments.

Conversion of contaminated fractures into aseptic fractures should be done within the first eight or ten hours by removal of foreign bodies, excision of debatable soft parts and perhaps of the small fragments; whenever practicable, the wound then should be closed by primary suture and the bones given external rigid support.

Closed fractures needing exposure of bone for readjustment of fragments probably do better, in respect of freedom from sepsis, if operated upon about seven days after injury.

Comminution of bone in closed fractures does not add much to the severity of the injury, but it requires that the external support and the accuracy of coaptation receive vigilant attention.

Comminuted open fractures, if kept aseptic or early rendered aseptic, do well, because the small fragments may furnish many centres of callus deposition.

Nearly all closed fractures and many open ones of the upper limb may be successfully treated as to functional ability and anatomical integrity by means of ambulatory dressings.

Nearly all fractures of the lower extremity, whether open or closed, do better when treated in bed with suspension of the limb and more or less continuous traction. An exception to the rule of treating fractures of the lower limb in bed may be made in fractures of the fibula and of bones of the foot.

Most fractures of the femur, and a considerable number of the tibia, must have strong traction added to suspension of the external fixation apparatus.

A few fractures of the upper limb, closed and open, require suspension with traction. This is particularly true in fractures of the upper end of the humerus, and is more frequently needed for infected fractures in this site.

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Fixation by external splinting is best given to the upper limb by using the thorax as a splint for the humerus; some form of plastic material moulded to the surface is usually best for the bones of the forearm. Encircling the arm or forearm is dangerous in the early stages of the treatment; it is liable to cause ischaemic myositis or gangrene.

When suspension and traction are required for upper limb fractures the patient should be kept in bed for a time; and external splinting should usually be obtained by steel rods used in similar form to the braces and splints advised in fractures of the lower limb or by a modified Buck's traction apparatus.

The suspension and traction so valuable in fractures of the femur may best be obtained by the N. R. Smith or Hodgen anterior heavy wire splint, the modified Thomas splint, or by traction with the Buck's extension method, with or without suspension, or by adoption of the Bradford frame. The Thomas splint is probably the best of these methods in adults with great overriding of the fragments. It is particularly valuable if the patient must be subjected to transportation.

The joints, muscles and skin in fracture cases should be given attention from beginning to end of treatment, if the best results are to be obtained.

Joints should not be kept immobile longer than one or two days. Careful passive and active movements usually should be allowed within the first few days, and frequently repeated during the course of the treatment.

It is a common practice to permit weight bearing on fractures of the lower extremity too soon. Secondary deformity is frequently caused by this error. Crutches and braces and other devices should be used to prevent such deformities.

No special form of splint or apparatus can be substituted with safety for that knowledge of anatomy, pathology and mechanical intelligence which constitutes a surgical grasp of the particular fracture needing professional care.

DR. JOHN H. GIBBON remarked upon the change that has taken place in the last five years regarding the treatment of fractures. A question of the utmost importance mentioned by Doctor Roberts is that of mobilization. Movement, both passive and active, is that which is most needed to-day in the treatment of fractures in civil life. In fractures of the thigh he had taken out more plates than he had put on. He recently saw the case of a boy operated on eight years ago for fracture of the thigh; it was plated with a good result. The boy suffered a refracture three weeks ago at the site of the last screw. Traction to overcome the deformity was unsuccessful. There was nothing to do but to operate, and he found a lot of blood serum, with pus, around the plate. There was no fever. He took away the plate, but could get only partial reduction. The wound was closed without drainage. This was three weeks ago. There is a good deal of union at this time.

BOOK REVIEWS

- I. DES ANDREAS VESALIUS SECHS ANATOMISCHE TAFELN vom Jahre 1538 in Lichtdruck. Neu herausgegeben und der 86 Versammlung Deutscher Naturforscher und Aertze zur Feier die 400 Wiederkehr des Jahres seiner Geburt, dargeboten von MORIZ HOLL (Graz) und KARL SUDHOFF (Leipzig). 1920. Verlag von Johann Ambrosius Barth in Leipzig. Boards, folio, tafeln 6.
- II. HISTORY AND BIBLIOGRAPHY OF ANATOMIC ILLUSTRATION in its relation to Anatomic Science and the Graphic Arts by LUDWIG CHOUANT. Translated and edited with notes and a biography by MORTIMER FRANK, B.S., M.D., of Chicago, with a biographical sketch of the translator and two additional sections by FIELDING H. GARRISON, M.D., and EDWARD C. STREETER, M.D. 1920. The University of Chicago Press, Chicago. Cloth, royal 8vo., pp. 435.
- III. THE SCHOOL OF SALERNUM (*Regimen Sanitatis Salernitanum*). The English version by SIR JOHN HARINGTON. History of the School of Salernum by FRANCIS R. PACKARD, M.D., and a Note on the Prehistory of the *Regimen Sanitatis* by FIELDING H. GARRISON, M.D. 1920. Paul B. Hoeber, New York. Cloth, 12mo., pp. 216.

The appearance of these books simultaneously upon the reviewer's table indicates a growing interest in the history of medicine and in medical bibliography. The influence of Billings, the creator of the magnificent collection of medical books constituting the Library of the Surgeon General's Office of the United States Army, the magnetic persuasions of Osler, the traditions of George Jackson Fisher, the bibliophilic country physician of Sing Sing, the example of Oliver Wendell Holmes and his gifts to the Boston Medical Library, the growing alcoves devoted to such books in the great medical libraries of New York, Brooklyn, Philadelphia and Baltimore, the publications of the Charaka Club which give an occasional hint of the transactions of that select organization, the "Annals of Medical History" edited by Packard and published by Hoeber, both of them antiquarian enthusiasts, the recent volumes on the "History of Medicine" by Buck and by Garrison, these together with numerous other notable influences have combined to give much impetus to the antiquarian cult among American medical men of late years. May it not be said also that it is both a sign and a result of a higher scholarship prevailing among the American profession? This interest in medical history has been accentuated also by the occurrence in 1914 of the four hundredth anniversary of the birth of the great anatomist, Vesalius, which obtained widespread observance in this country as well as in Europe.

In Germany the Society of Naturalists and Physicians at its Congress held in the spring of 1914 undertook in celebration of this Vesalian anni-

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versary the issual of a facsimile reprint of the famous six first anatomical plates which were published by Vesalius in 1538, as a preliminary proof and sample of the work in which he was engaged, which five years later, in the full magnificence of its completed form, burst upon the world in his "De Humani Corporis Fabrica" published in Basel by the printer Oporinus in 1543. The carrying out of this most praiseworthy plan of the German society was interfered with by the outbreak of the World War in the early summer of that year, but with the return of peace the project has been taken up anew with the result that this most interesting and valuable atlas is now in our hands, giving to every scholar the opportunity of becoming, by the outlay of sixty marks, the owner of a facsimile copy of what is one of the rarest medical *Preciosa*.

II. Ever since its publication in 1852 the work of Choulant, "Geschichte und Bibliographie der Anatomischen Abbildung," has been sought for as the final authority on all matters pertaining to the development of the use of graphic means for representing human anatomy, and as an inexhaustible mine of information on the subject. The German original has long been out of print, though occasional copies may have been procurable from the dealers in antiquarian medical books. One of the evidences of the increase of interest in medical history and bibliography, mentioned above, is to be found in the project of one of the younger medical enthusiasts of Chicago to translate Choulant's book into English and make it, with attractive and important additions, accessible to the medical profession of to-day. He had finished the task and turned the manuscript over to the publishers when he was overtaken by an untimely death, April 21, 1919. Through the interest of his professional friends the publication of the book was not permitted to be delayed, but rather hastened as a fitting memorial of Doctor Frank himself. The book is now before us. For many years we have been the fortunate possessor of a copy of the original and are delighted to be able to place by its side on the library shelf this copy in English with its important addenda. Frank has made it a much more *readable* book by simplifying its involved sentences and rendering them into clear, crisp English. To the original Frank has added accounts of the later researches made by Sudhoff and others among mediæval manuscripts. There are also supplementary sections on Sculpture and Painting as Modes of Anatomic Illustration, and Anatomic Illustration Since the Time of Choulant. The reader will be greatly attracted by the excellent portrait of Choulant which faces the title page. We wish that the memorial notice of Doctor Frank, from the pen of Garrison, might also have been accompanied by a portrait. The book is sure to meet with a wide and continued demand. New methods of book illustration have come into use—the facility with which recent reproducing processes make it possible to multiply photographic prints have fairly swamped the medical books of the present day with half-tone plates. Color lithography has made the free diffusion of colored plates

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easy; nevertheless, the glorious plates that illustrated the work of the anatomists from the time of von Calcar to that of Daguerre, will always remain of profound interest to the physician who is interested in the development of the science and art of medicine, while the crude attempts of the pre-Vesalian period will equally engage his attention as the early glimmerings of the dawn of a new day for medicine.

III. The *Regimen Sanitatis Salernitanum* enjoys a perennial youth. There are eighty odd mss. copies of it known to be extant, dating back to the years before the invention of printing, while Hough enumerates forty-seven editions of all kinds printed between the years 1474 and 1500. Sudhoff, indeed, traces its origin to a prose hygienic epistle (*De conservatione corporis humani*) supposed to have been written by Aristotle for the benefit of his pupil Alexander (the Great) which prose epistle bears a striking resemblance to the versified specimens of the "Regimen sanitatis" which latter began to appear in the twelfth century, in response to the demand for codes of hygienic rules for all the phases of life which seems to have become prevalent at that period. Packard, however, pronounces this Aristotle and Alexander combination to have been a fake, a mere Arabic business device, to give "go" to the product of a mediæval brain. The first English translation was published in 1530 by Thomas Paynel. In 1608 another English version appeared, attributed to Sir John Harington, of which this most recent of editions is a reprint. Dr. Francis Packard has prefaced the text of the "Regimen" with an interesting history of the School of Salernum, to which is added by Dr. Fielding Garrison a note on the Prehistory of the Regimen Sanitatis. Opposite the title page is a portrait of Harington. The typographical setting of the book is most attractive and is worthy of its subject. It makes a very excellent companion to the edition of the "Gold Headed Cane" previously issued by the same publisher.

Lewis S. PILCHER.

THE FORM AND FUNCTIONS OF THE CENTRAL NERVOUS SYSTEM. An Introduction to the Study of Nervous Diseases. By FREDERICK TILNEY, M.D., Ph.D., Professor of Neurology, Columbia University, and HENRY ALSOP RILEY, A.M., M.D., Associate in Neurology, Columbia University. Octavo, cloth, pp. 1020. New York. Paul B. Hoeber, 1921.

This volume, a credit to clinical neurology and an ornament to the Anatomy Department of Columbia University, is the result of years of earnest work and study. Nearly every page testifies that the authors have not spared themselves, either in examining the literature or studying specimens for the purpose of getting a deeper understanding of the form and functions of the central nervous system. Heretofore no single work has provided a clinical and physiological interpretation of the brain and spinal cord suitable to practical requirements. The authors' aim in this book is set forth in the introductory chapter as follows: "This work is designed to fill the gap between

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morphology and the practical requirements of clinical medicine. It aims to visualize the living nervous system, to make accessible an appreciation of its vital relations to the functions which go to make up life, as well as the defects in these relations which result in disease."

In reality the book covers five subjects: Embryology, Anatomy and Histology, Physiology, Pathology and Clinical Neurology, all blended into a harmonious whole. The result is that the student gets a clear interpretation and analysis of clinical neurology. The early chapters deal with the Embryological Development of the Central Nervous System. This contains a résumé of the former work of importance and some new and original investigation and many excellent illustrations. The Structural Unit of the Nervous System is next studied. It deals minutely with the histology and physiology of the nerve-cell and its processes. The different forms and functions of nerve-cells are described in detail and illustrated clearly. The neuron theory is supported. The Central Nervous System is then taken up, the Spinal Cord, Medulla, Pons, Cerebellum, Midbrain, Interbrain and Endbrain are studied successively. The same scheme is followed throughout in the presentation of each division of the central nervous system. First its general character and anatomy, followed by histology and physiology, and finally its principal syndromes which are presented by actual case histories. An anatomical interpretation and analysis is made of each case.

The entire study of the spinal cord and several divisions of the brain is so interesting, it is difficult to say which should receive the greatest commendation. Especial mention should be made of the chapters devoted to the cerebellum. The authors have contributed as much to our knowledge of the cerebellum as have any recent workers. Much may be found in these chapters which does not appear in any other text. Many new contributions on the functions of the thalamus and its divisions and also the Corpus Striatum may be found. In addition to their own original work they have drawn extensively on recent investigations of other authorities on the thalamus and basal ganglia.

The book as a whole is systematically arranged and logically presented. Each division of the central nervous system is studied minutely, yet concisely set forth. It is apparent that the text is best suited for students of neurology, but it should be a valuable addition to the library of any one interested in clinical medicine.

L. BEVERLEY CHANEY.

EDITORIAL COMMENT

Since July, 1903, the ANNALS OF SURGERY has borne upon its title page as one of its Editorial Collaborators the name of William Watson Cheyne. During all the years that have since elapsed this collaboration of Mr. Cheyne, now Sir W. Watson Cheyne, has been continued with great advantage to the ANNALS OF SURGERY and to the sincere gratification of its editor. It is therefore with much regret that he has received a recent letter from Sir Watson containing the information that on account of ill health he has definitely retired from active professional work and asks that some other name be substituted for his as the London Collaborator for the ANNALS OF SURGERY.

Of course, such a request is a command and has been reluctantly complied with. We take this occasion to express our deep appreciation of the many services which Sir Watson has rendered to the ANNALS during these eighteen years and to express the wish that in his retirement from active labor he may find a renewal of health, and that many years yet of useful and happy life may be reserved for him.

The vacancy thus created has been filled by Mr. W. H. Clayton Greene, Surgeon to St. Mary's Hospital of London, whose name appears on the title page of this issue of ANNALS OF SURGERY.

LEWIS S. PILCHER.

"FRAZIER ON SURGERY OF THE SPINE AND SPINAL CORD."

In the review of this book in the ANNALS OF SURGERY for January, page 138, the name of the publisher was inadvertently omitted. It should have been D. Appleton and Company, New York.

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